The National WIC Evaluation

An Evaluation of the Special Supplemental Food Program for Women, Infants, and Children

Volume III: Technical

Chapters IV, V, VI, VII, and References

Submitted to

Office of Analysis and Evaluation
Food and Nutrition Service
Department of Agriculture

Principal Investigator
David Rush, MD

Prepared by

Research Triangle Institute
New York State Research Foundation for Mental Hygiene

Supported by Contract No. 53-3198-9-87

PREFACE

The evaluation of the Special Supplemental Food Program for Women, Infants and Children (WIC), designated here as the National WIC Evaluation, is a project undertaken by the Research Triangle Institute (RTI) under contract with the Office of Analysis and Evaluation, Food and Nutrition Service (FNS), United States Department of Agriculture (Contract No. 53-3198-9-87). The National WIC Evaluation is documented in this summary report and more comprehensively in four technical volumes: Volumes II and III - Technical Report and Volume IV and V - Appendixes. The summary report is written for the reader who wishes a brief nontechnical overview of the WIC program, an explanation of the logic of the National WIC Evaluation, and a discussion of its important results and conclusions. The technical report presents complete discussions of methodology, database construction, analysis techniques, results, and conclusions. The appendixes present copies of all data collection instruments used in the evaluation and supplementary tables referred to in the technical report.

This report covers the four component studies, namely the Historical Study of Pregnancy Outcomes, the Longitudinal Study of Pregnant Women, the Study of Infants and Children, and the Food Expenditures Study, upon which the National WIC Evaluation is based. These studies were designed primarily by the Principal Investigator, Dr. David Rush, with support from RTI staff and consultants, in the fall and winter of 1981-82. Dr. Rush's services, together with a small supporting staff, were made possible through a subcontract with the New York State Research Foundation for Mental Hygiene (NYRFMH).

Actual implementation of the studies began in the summer of 1982, with the major field data collection effort occurring during 1983. While RTI undertook major responsibility for organizing and managing the field effort, processing the data and preparing the basic data files, the entire effort was directed by Dr. Rush and carried out with support from his NYRFMH staff. The major analysis and reporting tasks were also carried out by Dr. Rush and his staff for three of the four component studies, with extensive support from RTI staff. The fourth study, concerned with food expenditures, was analyzed and the report prepared by RTI staff.

The success of the Historical Study was due in large part to the efforts of the State WIC program directors who, with their staff, provided annual counts of WIC women for individual clinics during the period 1974 to 1981. Considerable cooperation was also received from State directors of vital records who provided complete files of births and linked infant deaths for the period 1972 to 1980.

The Longitudinal Study, the Study of Children, and the Food Expenditures Study all acquired data through a national probability sample of pregnant women enrolled in the WIC program and a sample of low-income pregnant women not enrolled in WIC. The success of these samples and the success of the total data collection effort depended in no small part on the excellent cooperation of the directors and staff of the 174 WIC clinics and the directors and staff of the 55 non-WIC clinics that participated in the field phase of the study.

Both the study design and early drafts of this report were reviewed and critiqued by the FNS Advisory Panel to the National WIC Evaluation. The members of this Panel are listed on the inside cover.

The National WIC Evaluation received considerable support and valuable review and advice from the FNS Office of Analysis and Evaluation Project Officers Mr. David Shanklin and Dr. Burleigh Seaver. Particularly helpful were the review and comments of earlier drafts of this report by Dr. Seaver and by Ms. Nancy Chetry of the FNS Special Supplemental Food Division.

Finally, the consistently valuable, timely and able administration of the project by Ms. Sally Johnson is recognized.

D. G. Horvitz
Project Director

CONTENTS

CONTENTS (continued)

TABLES (continued)

TABLES (continued)

TABLES (continued)

TABLES

TABLES (continued)

CONTENTS (continued)

FIGURES

IV. FIELD METHODOLOGY: LONGITUDINAL STUDY/CHILD STUDY/FOOD EXPENDITURES STUDY

This chapter describes the methodology of the field surveys, including sample design and selection; instrumentation; procedures for hiring and training field personnel; data collection field operations; data receipt, editing, and coding; and data processing. It also presents descriptive statistics of the study samples, including the clinics and sites, and compares the WIC and non-WIC respondents for both the pregnant women and the child samples.

A. SAMPLE DESIGN AND SELECTION

The data for the Longitudinal Study were gathered from a nationally representative probability sample of pregnant WIC participants and a sample of control women of comparable economic status. Controls were low-income pregnant women whose income qualified them for, but who were not participants in, the WIC program. They were recruited from hospital and public health clinics in counties either not served by WIC or where WIC penetration was not high. The control sample was also recruited nationwide but was not a representative sample of all non-WIC low-income women because there was no way to recruit women receiving care from private practitioners. The sampling was intended to yield approximately 6,000 women in the first two trimesters of pregnancy, one-third of whom would be controls.

The probability sampling design had three stages. The first-stage or primary sampling units (PSUs) were counties or groups of contiguous counties. The size of PSUs was such that one field operative could be responsible for all necessary field activities. The second-stage sampling units were WIC or control clinics within sampled PSUs. Finally, pregnant women were sampled within the selected clinics. Frame construction, sample allocation, and selection at each of the three stages are described in the following paragraphs.

1. <u>Frame Construction, Allocation of Sample, and Sample Selection</u>

<u>Longitudinal Study</u>

The PSUs consisted of contiguous counties* aggregated to yield a minimum number of women who were eligible for either the WIC or the non-WIC sample. All pregnant women in the first two trimesters of pregnancy who enrolled in the WIC program during the 4-month recruitment period were eligible for the WIC sample. Women were eligible for the non-WIC sample if they began prenatal care at non-WIC clinics during the data collection period and if their incomes qualified them for WIC.

---

*Alaska and Hawaii were excluded from this study to control data collection costs. The District of Columbia was included and is herein referred to as a "county."

Counties where the WIC program served more than 30 percent of eligible pregnant women were excluded from the non-WIC sample.* Counties with fewer than 15 eligible births each year were judged to be so small that when they were combined with other such counties the resulting area would be too large to study economically. Thus, the study excluded counties with only 6 percent of WIC participants and 21 percent of possible control women.

Enough counties were aggregated into PSUs to reach an estimated number of total eligible births. Original plans called for a sample of approximately 165 sample women from each of approximately 80 sample PSUs. However, the estimated total numbers of eligible women in many counties were extremely small. This led to the decision to construct two types of PSUs: full PSUs, in which close to the originally planned number of sample women per PSU was selected, and half PSUs, in which half as many sample women were selected. Half PSUs, with their reduced minimum number of eligible women, could be assigned to one field operative.

Because of the scarcity and generally wide geographic dispersion of eligible control women, non-WIC areas with a high concentration of eligible women were oversampled. Therefore, the 15 counties with the largest estimated number of non-WIC eligible women were classified into a stratum of large non-WIC counties. Each of these counties constituted a single full PSU. The remaining PSUs were classified into a stratum of full PSUs and one of half PSUs. The WIC sample was allocated to the strata in proportion to the number of WIC-eligible individuals. Approximately one-third of the non-WIC sample was allocated to the large non-WIC stratum, and the remaining non-WIC sample was allocated to the other two strata in proportion to the number of non-WIC eligibles.

The sample PSUs were selected through probability minimum replacement sampling. Initially 10 selections were made from the large non-WIC stratum, 37 from the full-PSU stratum, and 33 from the half-PSU stratum. This sample was designed to yield self-weighting within each group of women (i.e., the within-group sampling fractions were equal). Following the selection of the first-stage sample, the second-stage sampling frame was constructed. This consisted of currently operating WIC clinics and, in counties eligible for inclusion in the non-WIC portion of the study, clinics that served non-WIC low-income pregnant women. The latter included hospitals in the counties that had outpatient prenatal health clinics.

Following construction of the list described above, each outpatient clinic site that served low-income women was telephoned, and an estimate was obtained of the number of women enrolling in prenatal care each month. In addition, the percentage of these women who subsequently enrolled in the WIC program was obtained. This information was used to estimate the number of eligible non-WIC women that could be expected at each of the sample sites.

---

*Defined as large counties, the criterion was less than 40 percent served.

A continuing assessment of the number of operatives (interviewers) who would be needed to cover the sample and the time required for traveling made it apparent that covering the half-PSU stratum was going to cost more than the budget could support. Thus, this stratum was subsampled and reduced by 14 PSUs. The subsampling was carried out to preserve the self-weighting of the WIC sample to the extent that the number of women available in the PSU would permit. This resulted in a sample of 10 large non-WIC PSUs, 36 full-PSUs, and 20 half-PSUs.

At the second stage, a sample of WIC clinics was drawn through circular systematic sampling. The expected number of eligible women was estimated for each clinic within the sample PSU. The clinics were ordered within the PSU. In most cases they were ordered as largest, smallest, next largest, next smallest, and so on, to reduce the number of different sites where data would be collected. In some cases where clinic sites were widely distributed throughout the PSU, the clinics were ordered by Research Triangle Institute (RTI) staff to minimize the geographic spread of the sample.

The sampling interval that would be required to yield the required overall selection probability was then determined. A random start number was chosen, and the beginning and ending number of the sample interval was determined. The clinics that overlapped this sample interval were selected for the study.

Strict implementation of this procedure required that some clinics be split. For example, if a clinic had 50 women and the sample interval overlapped the clinic by 25 women, only 50 percent of the clinic's women were included in the sample. This procedure resulted in each woman in the PSU having an equal chance of entering the sample and in the sample consisting of a two-stage selection of counties and women. The overlap of clinics merely indicates where the sample women are located. This procedure resulted in the selection of 256 WIC clinics and 117 non-WIC clinics across the 66 PSUs.

Following selection of the sample clinics, each sample clinic was contacted to arrange for participation and to obtain additional information on days that the clinic was open for new entrants and the number of women that could be expected to enroll during the study period. It became apparent that the sample would yield substantially fewer non-WIC women than had been anticipated. This was due to refusals of sample clinics to participate, the presence of fewer low-income women than had been estimated during the telephone calls to these sites, and the discovery of selected non-WIC sites that by the time of the contact had WIC onsite or were planning to start a WIC program during the 3-month data collection period. Thus, it was decided not to restrict the sample of non-WIC women to those originally specified by the sampling structure described above, and procedures for bringing additional non-WIC women into the sample were implemented. All counties adjacent to the selected PSUs were included in the study if they appeared to have a sufficient number of non-WIC women. In addition, it was

decided to include all non-WIC clinic sites that had been listed, but not previously selected, and to attempt to induct all non-WIC women within these sites. The net result of these activities was that the probability structure of the non-WIC sample was compromised. However, the original structure of the sample restricted the non-WIC women to counties that had low WIC penetration and to women who received prenatal care in clinic settings. While the estimated overall proportion of low-income women who receive their care at clinic settings is about 25 percent, this type of care is largely confined to urban settings. The result of this uneven distribution of clinic care was that fewer than expected numbers of non-WIC women could be found in the more rural areas. Only one of the PSUs in Stratum 3 yielded any non-WIC women. Thus, the sample of non-WIC women included in the study is not a probability sample of all non-WIC low-income pregnant women, but it is geographically distributed and is probably the best possible sample given the study's operating constraints. Because of the pragmatic steps taken to augment the non-WIC sample, sample weights were not calculated for the non-WIC women.

The sample of WIC women had been designated so that sampling within clinics would be necessary in some cases. Following selection of the sample, concern arose as to whether the imposition of sampling within the clinic would cause women to be missed because of the necessity to induct a particular woman into the sample. Accordingly, it was decided not to use systematic sampling within the clinics, but rather to take as many women as possible in each sample clinic, regardless of whether or not the clinic had been slated to be split. It was recognized, however, that only a portion of the women arriving at the sample clinics were included in the survey. Thus, the longitudinal WIC sample can be viewed as a three-stage sample with clinics being the second stage and women being the third stage of sampling. This view required the calculation of a weight for WIC clinics and a weight for WIC women. The weight for a particular clinic was calculated as the reciprocal of the expected number of sample intervals over all possible random starts that overlap it.

At the third stage, the "clinic capture rate" was calculated. Assuming that women arrive at the clinics in random order and that the portion of a clinic's clients included in the sample is a random subset of all eligible women arriving at the clinic, this capture rate may be considered a sampling rate. This rate was the basis for the women's weighting.

The original study specifications excluded women who were more than 6 months pregnant when they enrolled in the WIC program or when they entered prenatal care. Based upon information from publications by the National Center for Health Statistics (NCHS), it had been estimated that 8 percent of the women entering the program would be more than 6 months pregnant. The actual proportion of women more than 6 months pregnant was much larger, about 15 percent for the non-WIC women and 35 percent for the WIC women. Thus, after 10 weeks of data collection, it was decided to enroll women more than 6 months pregnant. In addition, the data collection period was increased to 18 weeks from the originally planned 13 weeks.

Modifications in the PSU and clinic selections resulted in an adjustment of sample size. The final estimate based on 10 large PSUs, 36 full-PSUs, and 20 half-PSUs was 9,270 women (6,211 WIC and 3,059 non-WIC). Before the beginning of the study, the sample was further reduced by 6 PSUs that were too large to cover economically. In addition, two PSUs (one full-PSU and one half-PSU) located in Indian reservations were dropped from the sample because the Indian WIC organizational structure was a separate entity requiring special attention and because the population served has special problems that could confound the findings of the study. Even with the modifications of enrollment procedures described, however, only 8,037 eligible women were encountered in the clinics. In all, 6,320 WIC and 1,717 non-WIC women were identified, and 5,205 WIC and 1,358 non-WIC women actually completed initial interviews in 58 PSUs (10 large, 34 full, and 14 half).

An additional modification to the study required by budgetary constraints was that only three-quarters of the women were given the dietary interviews. A simple random sample of all women included in the study was selected for the dietary interviews.

Child Study

A sample of children of WIC and non-WIC women was also selected. This sample was confined to children less than 5 years of age who resided in the mother's household. All children less than 5 years of age were listed and a random child selected for the study. This was done by providing each computer-generated Assignment Control Form (ACF) with a random ordering of the digits 1 to 6. The random ordering was consulted to determine the line number of the sample child from the six or fewer listed. Thus,

Child's sampling rate = women's sampling rate × 1/number of listed children.

This basic child sample was selected for use in the Child Dietary Study. In addition, any 5-year-old child who resided in a household where there was a sample child received a psychological interview. All children who were 4 years old also received a psychological interview. These children were not sampled. The actual yield of children in the study was smaller than expected because the number of women who had previously borne a child was much smaller than expected.

Food Expenditures Study

All women initially interviewed completed the recall component of the study. A simple random subsample of the sample women was selected for the diary component of the Food Expenditures Study, designed to yield 750 WIC and 750 non-WIC women.

2. Weighting

Weights were calculated only for the WIC sample. These weights were calculated as the inverse of the selection probabilities and were further

adjusted for nonresponse. The nonresponse adjustment was calculated within the six length-of-pregnancy-by-stratum groups as the sum of the weights of all eligible women divided by the sum of the weights for the responding women. No separate weights were calculated for the diary subsample, the dietary subsample, or the children's sample.

The above weights were the basis for all additional weighting activities. Respondents to the initial survey were the only women included in all followup activities. Weights were calculated for the Followup Survey respondents, for the respondents to the Hospital Abstract Followup Study, and for the Voucher Study. In each case, the only additional activity necessary was to determine the status of each initial survey respondent in each of these subsequent data collection activities. Nonresponse adjustments were calculated within six length-of-pregnancy-by-stratum groups as the ratio of the total sum of weights of women designated for inclusion in the study component to the sum of weights of those who responded to the study component.

Because of the nature of the within clinic selection of women, the sample selection probabilities for the study cannot be viewed as exact but as reflecting the relative chances that the WIC women entered the sample. Thus, persons using the sample data should be cautioned not to use the WIC sample weights to estimate totals but to confine the weighted estimates to means and proportions.

B. INSTRUMENTATION

Questionnaires and other data collection forms were developed and used in each data collection phase of The National WIC Evaluation. The data collection phases included (1) clinic contacts; (2) Initial or Time 1 Interviews with sample women and children, (3) Followup Interviews with sample women, (4) WIC voucher issuance data collection, and (5) birth outcome data collection. The main questionnaires used in each phase of data collection are described in the following sections. Copies are included in Volume V, Instrumentation.

1. Clinic Questionnaires

Two questionnaires were developed and used to collect data about each sample clinic's operations, procedures, and services offered to patients. The purpose was to identify a clinic's administrative procedures, to facilitate data collection, and to relate individual sample members responses to a clinic's procedures. Two versions of a Clinic Administrator Questionnaire were developed, one for use in sample WIC clinics and one for non-WIC clinics. The same Nutrition Education Questionnaire was used to collect data about the clinic's nutrition education program regardless of WIC or non-WIC status. Both questionnaires were designed to be self-administered.

The WIC-Site Clinic Administrator's Questionnaire and the Clinic Administrator's Questionnaire (non-WIC version) were designed to elicit specific, descriptive information about the selected sample clinics. The

information collected included details about the geographic area the clinic served, sponsorship of the clinic, client or patient characteristics, client or patient eligibility criteria, types of services provided, clinic operating schedule, and types and characteristics of clinic staff members. Both questionnaires also contained a request for the administrator to provide RTI with samples of application forms potential patients were required to complete.

The Nutrition Education Questionnaire was developed to collect data about the types, content, and extent of nutrition education the clinic staff provided to pregnant women at the sample sites. Also collected were details about the qualifications of staff assigned to provide nutrition education; factors that limited provision of nutrition education; and data about written plans, guidelines, and instructions used to teach nutrition education. A request for the nutritionist to provide RTI with examples of educational materials distributed to pregnant women also was contained within the questionnaire.

2. Women's Interviews

The main instruments used in the second phase of data collection, the Longitudinal Study of Pregnant Women, were Screening Forms, the Initial Interview Package, the Followup Interview Sheet, and the Followup Interview Package.

WIC and Clinic Site Screening Forms, which were used in the Initial Interviews (Time 1), contained the screening questions to determine whether a woman met the study enrollment criteria. Because the study eligibility criteria were different for WIC and non-WIC women, two forms were developed and used: the WIC Site Screening Form was used at sample WIC clinics and the Clinic Site Screening Form was used at sample non-WIC clinics. The forms were reproduced on different colored paper so field operatives who worked at both types of clinics could readily distinguish between the two. In addition to the screening questions, the screening forms contained spaces to document the woman's name, address, and phone number; clinic identification information; and results of the screening. Appropriate routing instructions were printed on each form to guide the interviewer to the next appropriate action with the woman.

The Initial Interview Package was administered to all women, both WIC and non-WIC, who met the study eligibility criteria during the Time 1 Interview screening and who were willing to participate in the study. The package contained questions on the respondent's current pregnancy and previous pregnancy history, background information on the woman and the father of the baby she was expecting, household income, family food expenditures, and use of WIC and prenatal medical care services. The Initial Interview Package also included the 24-Hour Dietary Recall Interview, the Women's Measurement Form, the Household Roster, and instructions for selecting a sample child if the woman had a child 5 years old or younger. These sections were all bound into one instrument, termed the "Initial Interview Package." The package was reproduced that way for easy handling by the field operative and for easy data processing and storage.

In addition to administering the instruments described above, the field operatives completed the Consent Form and the Authorization Form during the Initial Interview. The Authorization Form, which was a legal document addressed to the sample woman's expected hospital of delivery, asked and authorized the hospital of delivery to release data from the woman's prenatal/delivery/newborn infant records. Each woman was asked to sign this form during the Initial Interview and to confirm the place of delivery during the Followup Interview.

The Followup Interview Data Sheet (FIDS), used during the second or Followup Interview with each sample woman, served as an assignment form and as a notice to the field operative that the woman was due for a second interview. It contained the clinic and woman's identification information; the woman's name, address, and telephone number; and locator information. Information necessary to complete the second interview, such as the date of the Initial Interview, the followup period (e.g., the period in which the second Interview was to be completed), and an indication of whether or not the woman was included in the food expenditures diary sample, also was included on the FIDS. The FIDS also contained a space for the operative to document the results of all contacts and attempted contacts with the sample woman.

The Followup Interview Package was the main data collection instrument used in the second interview with each sample woman. It contained questions about the woman's prenatal care, her health during the pregnancy, experience with and advice about nutrition and infant feeding methods, housing characteristics and occupation, and receipt of WIC services. The 24-Hour Dietary Recall Interview, the Women's Measurement Form, and the Family Food Expenditures Sections also were contained with the Followup Interview Package.

A sample of the women who participated in the Initial Interviews was selected to complete a Food Expenditures Diary, which was part of the Followup Interview data collection used for the Food Expenditures Study. Two separate survey instruments were used in this component of the study: the Diary Placement and Pick-Up Questionnaire and the Record of Your Daily Food Costs, often referred to as simply "the Diary." The Diary Placement and Pick-Up Questionnaire was used by the field operatives as a guide to instruct the sample woman in the use and completion of the Diary. The Placement and Pick-Up Questionnaire also contained spaces for the operative to document the Diary reference period and the results (i.e., whether the sample woman completed the form or, if it was not completed, the reason it was incomplete). The Diary was designed so that on each of the 7 days within the reference period the sample woman (or someone else in the household who was knowledgeable of the family's food expenditures) could easily list the foods purchased, the cost of each food item, and the preparation status (fresh, frozen, canned, etc.) of each food item when it was purchased. The field operative's name and telephone number were listed on the Diary so the sample woman could call if she had questions about the completion of the Diary.

3. Child's Interviews

The Child's Interview Package was the primary data collection instrument used in the Child's Study, which was implemented during the Initial Interviews with sample women during the second phase of data collection. The Child's Consent Form was completed before data were collected for any child. The Child's Interview Package was similar to the Initial and Followup Interview Packages administered to women in that it contained all sections for the major components of the interview, including the 24-Hour Dietary Recall Interview and the Child's Measurement Form. The Child's Interview Package also contained questions about the child's health status, immunizations, use of medical care services, and previous WIC enrollment. In addition, the package contained the weight for length/height charts used by field operatives to chart the child's weight for height and instructions for administering the Peabody Picture Vocabulary Test and the McCarthy Numerical Memory Test (1972) to the child. Because components of the interview with children varied according to whether the child was the selected sample child or another eligible child, the Child's Interview Package contained routine instructions for the field operative to follow to ensure that the appropriate sections and components of the interview were administered to the mother and/or the child.

4. Birth Outcome Data Collection Instruments

The third phase of data collection involved contacting hospitals where the sample women delivered their babies to collect data on the outcome of the pregnancy. Two main forms were used in this phase of data collection: the Authorization Form described previously and the Hospital Records Abstract Form (HRAF). The HRAF was designed to collect information about the status of the woman's health on the date of her last prenatal visit (if the prenatal record was available at the hospital of delivery), on the outcome of the pregnancy (e.g., delivery date or date the pregnancy was terminated, type of delivery, and abnormalities of labor), and on the vital status of the infant (i.e., the infant's sex, birthweight, birth length, neonatal illnesses, and feeding method). The HRAF was designed so hospital medical records staff could abstract the required data.

In addition to the Authorization Form and the HRAF, a Hospital Infant Measurement Protocol Form was used to collect data about the hospital's procedures for weighing and taking length measurements of newborn infants. These data were necessary to analyze the data collected on birthweight and birth length. This form was completed by the hospital's Director of Obstetrics or the head nurse in charge of obstetrics at each hospital.

5. WIC Voucher Issuance Data Collection Form

The fourth phase of data collection was the collection of information about the frequency of distribution of foods or food vouchers and the types of foods prescribed for and issued to each sample WIC woman. The WIC Food

Voucher Issuance Form was the main instrument used in this component of the study.

6. Instruments to Assess Local WIC Program Effectiveness

A 1-page questionnaire was developed to be completed by State WIC Directors of local WIC programs participating in the Longitudinal Study of Pregnant Women. The purpose of the instrument was to assess the variability in program quality among participating local WIC sites. Through several State WIC Directors, issues were identified that distinguished good local program performance, and the resultant scale was pretested among several State WIC Directors. Questions were included on the following: the amount of counseling provided, quality of nutrition education, quality of individual care plans, efficiency of voucher or food package distribution, integration with health care system, overall staff excellence/qualifications, staff motivation and morale, compliance with Federal and State policies and procedures, outreach to the community, and overall rating of the WIC site. During the study, the questionnaire was sent to State WIC Directors in order to rank each local program in which Longitudinal Study subjects were recruited.

7. Pretest of Instruments

Small informal pretests of selected sections of the Women's Initial Interview Package and the Child's Interview Package were conducted in a New York City hospital WIC office and prenatal clinic in both Spanish and English and in a WIC office in Raleigh, North Carolina, before the survey instruments were finalized. The purpose was to test the readability of the questions and the respondent's ability to understand the questions as they were written, to detect problems/errors in routing or skip instructions, and to obtain an average time to complete each section of the interview package. The pretest resulted in some questions being eliminated, some lengthy questions being reworded or reformatted, and identification and correction of routing errors.

An informal pretest of the 24-Hour Dietary Recall was conducted by the project staff in New York. This pretest, which involved patients at a WIC site and a prenatal clinic in the New York City area, was conducted to evaluate the format of the 24-Hour Dietary Recall Section and to obtain an average time to complete such an interview in both English and Spanish.

C. FIELD PREPARATION

1. Recruitment and Selection of Personnel

RTI's 12 offsite field supervisors supervised data collection activities for all phases of data collection except birth outcome. The supervisors reported to and were supervised by two central office regional supervisors, who made territorial assignments based on the city where the field supervisors lived. Each field supervisor was responsible for data collection within his or her respective area and each managed, on average, a staff of eight field operatives.

Recruitment of qualified field operatives was accomplished by joint effort of the central office project staff and the field supervisors. Applications were received from women responding to advertisements, which had been placed in newspapers in cities located in or near most PSUs, and from veteran RTI interviewers who had been notified of the study by RTI. Field supervisors also utilized other sources to find leads to qualified persons. These sources included field managers at other research companies, the U.S. Bureau of the Census, college and university placement services, schools of public health, and departments of sociology. Officials at sample WIC clinics in some areas also furnished some leads.

The recruiting operation for qualified field operatives resulted in applications from 398 women. Of these, 244 were considered as possible candidates and 98 were eventually hired as field operatives. The number hired in each area was based on the number of sample clinics in each PSU, the proximity of clinics in the PSU, and the expected yield of pregnant women in each sample clinic.

2. Public Relations and Initial Clinic Calls

In preparation for the field work, the FNS Project Officer and other staff members sent memoranda to the seven Regional WIC Program Directors and to all State WIC Program Directors early in the fall of 1982 before the sample PSUs were selected. The purpose of these memoranda was to introduce the study to these officials and to apprise them of activities as the study progressed. The memoranda were also part of an effort to follow the normal WIC program communications protocol.

Similar memoranda, signed by the RTI Project Director and the Principal Investigator, were sent to the Public Health Director and the Director of Maternal and Infant Health in each State. Following selection of sample clinics, a letter explaining the study and containing a list of selected sample clinics was sent to county public health and WIC program (district) officials. This letter, also sent to the administrator of each selected clinic, advised the county/local officials and the clinic administrators that one of RTI's field supervisors would contact them to arrange a meeting to discuss the study in more detail.

In addition to memoranda and letters sent to WIC and public health officials, the FNS Project Officer, RTI Project Director, and Principal Investigator visited two States to address concerns regarding the study. Special concerns expressed by officials in other States also required special letters and/or telephone calls from project staff. As the study progressed, additional letters were sent to WIC and public health officials. Such letters were usually sent as a result of changes in the data collection procedures and/or schedule.

3. Procurement and Distribution of Special Equipment and Supplies

Because of the nature of the WIC Study, it was determined that special equipment would be needed to conduct the field work. Most of the items of

equipment, considered nonexpendable, were purchased to take anthropometric measurements of women and children or to conduct the Dietary Assessment Interview. These items were purchased from various companies, assembled into an easy-to-use kit, and packed in sturdy travel cases. (The Gerber Company of Fremont, Michigan, contributed and shipped free of charge more than 1,000 baby food bottles and jars to be used in the Dietary Interview Kit, and Ross Laboratories of Columbus, Ohio, contributed several hundred insertion tapes to be used for anthropometric measurements.) Equipment and items purchased for the anthropometric measurements and the Dietary Assessment Interviews are described in Volume V, Instrumentation.

The procurement of supplies also involved contacting several private companies for help in providing incentives to women who participated in the study. Coupons for a discount on disposable diapers were donated by Kimberly Clark, and sample packages of diaper rash ointment were donated by Pfizer, Inc.

All nonexpendable equipment was shipped by first-class mail and UPS to the field operatives prior to data collection. A supply of questionnaires, which had been reproduced by private printing companies under contract to RTI, as well as administrative forms printed at RTI were distributed to the field staff 2 weeks prior to data collection. Additional supplies were sent upon the operative's request thereafter.

D. FIELD STAFF TRAINING

1. Training Schedule

The field operatives and eight of the field supervisors were trained on both Initial Interview and Followup Interview procedures at one of four 5-day regional training sessions held in Las Vegas, Nevada; Philadelphia, Pennsylvania; St. Louis, Missouri; and Atlanta, Georgia. Sessions were held in Philadelphia and Las Vegas during the same week, and, in the latter two cities, sessions were held the following week. The centralized training session sites and staggered training sessions were held so that each session could be staffed by an RTI lead trainer, an NYSRF representative, and one of four field supervisors who had been trained earlier at preparation sessions as assistants.

Three makeup training sessions were held at RTI in the 3-month period after the Initial Interview data collection had begun. These sessions were held to train operatives who were hired after the field work had begun and for those who had been hired earlier but who could not attend one of the four regional sessions. Each operative received additional training on the Followup Interview procedures by completing self-study training materials. This training, which focused only on new procedures and instruments not covered in the main training session, was held in April 1983.

2. Training Materials

The Field Procedures Manual was the primary document developed to train the field staff. This manual included detailed discussions of all aspects of the study, including specifications for completing the survey

instruments, procedures for taking body measurements, and procedures for conducting Dietary Assessment Interviews.

A study guide was also developed for the operatives to use when reading the manual. The guide presented instructions for reading each section of the manual followed by questions pertaining to that section or passage. The Study Guide and the Field Procedures Manual were sent to the field staff members approximately 1 week before their training session began. Field operatives were instructed to spend up to 16 hours reading the manual and completing the questions in the Study Guide prior to attending their training session.

To make sure that all operatives received uniform and standardized training, trainers used a training guide, which contained a complete near-verbatim script for discussion of all aspects of interview procedures and specifications. The Training Guide instructed the trainers in the time to allow for each discussion and observations to make about each operative's performance; it also listed the materials and equipment needed for each discussion.

Written classroom exercises, which were designed to reinforce the discussion of the interview procedures and instrument specifications, were also used during the training session. Some classroom exercises were written questions about interview procedures or survey instrument specifications. Other exercises provided a scenario of an interview situation that required the operative to complete a survey form or describe the correct interview procedures according to the information given in the scenario.

As mentioned above, the training of operatives on the followup interview procedures was accomplished by self-study and a training call to the field supervisor. A Followup Interview Self-Study Workbook was sent to each operative with instructions for review and completion. The Followup Interview Self-Study Workbook contained procedural specifications for the placement and pickup of the Diary, which was the only survey instrument not covered during the main training session held before the data collection began. The Workbook also contained a discussion of other components of the Followup Interview, emphasizing contacting the sample woman and scheduling the interviews.

3. <u>Training Methods</u>

The methods used to train the field staff during the training session held prior to the beginning of data collection included the following:

- Trainer exposition on interview procedures and question specifications.

- Question and answer review of interview procedures and specifications.

- Demonstration interviews, which were designed to illustrate the flow of the interview.

- Round-robin mock interviews, where a trainer served as the respondent and operatives took turns being the interviewer.

- Practice interviews in pairs, where operatives took turns interviewing each other (this was done for both questionnaire administration and for Dietary Assessment Interviews).*

- Practice sessions for taking body measurements of women and children.*

- Practice sessions to gain experience in administering psychological tests to children (the operatives administered the tests to other operatives).

- Completion of classroom exercises that had been designed to reinforce the review of the specifications and interview procedures.

The practice sessions for taking body measurements of women involved the operative's measuring female trainers and field supervisors and then measuring fellow trainees. Several children between the ages of 6 months and 5 years were used to give the operatives practice in taking children's body measurements. Arrangements for the use of these children were made by project staff in advance of the training session. Individuals who agreed to bring their children to the training site were reimbursed (at $20.00 per child) for travel, time, and expenses.

E. FIELD OPERATIONS

Data collection for The National WIC Evaluation focused on the initial enrollment of study-eligible women at the sample clinics. These women became the direct source of data for the Longitudinal Study and the Food Expenditures Study and indirectly, the source of data for the Study of Infants and Children by volunteering their children under the age of 6 to take part in that component of the project.

1. Assignments and Schedule

Initial assignments were made to operatives based on the size of each PSU, the number of clinics selected, the expected yield of eligible patients, and the operating schedules of the clinics. A field operative was responsible for enrolling study eligibles at one or more selected clinics in a PSU, but the actual collection activities were often shared between or among two or more field operatives.

---

*A more extensive discussion of training in dietary methodology and body measurement can be found in Volume V, Instrumentation.

Table IV-1

Field Operations Data Collection Schedule

Collection task	Date started	Date ended
Initial Interviews	February 7, 1983	June 6, 1983
Child Interviews	February 7, 1983	June 13, 1983
Followup Interviews	April 11, 1983	November 30, 1983
Birth outcome abstractions	October 1, 1983	February 15, 1984
WIC voucher data abstractions	November 15, 1983	December 15, 1983

Because of the staggered training schedule, the first day of data collection also varied. The first possible day for data collection (enrollment of eligible women at selected clinics) was February 7, 1983. The final day for enrollment and completion of the Initial Interviews for the project was June 6, 1983. Listed in Table IV-1 are the specific start and end dates for the field operations data collection schedule.

2. Procedures

After training, operatives were responsible for contacting their assigned clinics and establishing working relationships with the designated study coordinators. Most of the problems associated with adapting the clinic settings to the study protocol had been resolved during introductory meetings between the field data collection supervisors and the clinic administrators/coordinators. During the initial contacts by field operatives, the discussions dealt more with the details of day-to-day operations (e.g., rooms to be used, schedule of daily clinic hours, and where height measurement devices were to be installed).

Interview Setting

All Initial Interviews with women in the Longitudinal Study/Food Expenditures study were conducted in the clinics where the women were first encountered and enrolled. These were essentially the women's first trips to clinics for services or care. During the Followup Interviews, approximately 90 percent were interviewed at the original enrollment location. The remainder usually were interviewed in their homes because they did not intend to return to the original enrollment clinic during the specified time period.

For the Child Study, the settings were usually the respondents' homes. In a few instances the Child Interviews were completed at the clinics because the child was with the mother and it was convenient to complete it at that time. This occurred, however, in only 1 or 2 percent of the cases. In 10 to 15 percent of the Child Interviews, the part of the interview that

could be completed with the mother was done at the clinic and then only the part where the child was physically measured or tested was conducted in the home during the evening or on a day when the clinic was closed.

For collection of WIC voucher information, the clinic was the predominant setting. A few instances occurred where an operative needed to abstract data from older records held at some remote storage location, like a garage or warehouse, but this was the exception. The abstraction of birth records was carried out in the medical records departments of the hospitals of delivery. A few operatives (approximately 10) were involved in the birth record abstraction task, and a small number of records were abstracted or copies secured from storage locations not at the hospital location. For practical purposes, virtually all birth record data were collected by hospital staff at hospitals.

Screening Procedures

Study eligible women were identified through screening interviews conducted on the first date women were certified to receive WIC program assistance or to receive prenatal care. In WIC clinics, women were defined as ineligible if they:

- Were certified previously for WIC for the current pregnancy.
- Were more than 6 months or 26 weeks pregnant (except during the period from April 15 through June 6, 1983, when women more than 6 months or 26 weeks were eligible).
- Planned to move outside of the immediate area before they delivered their babies.

A similar set of eligibility rules was established for use in the non-WIC clinics. At non-WIC sites, women were determined to be ineligible if they:

- Had prior prenatal visits for other than diagnosis for this pregnancy.
- Were more than 6 months or 26 weeks pregnant (except during the period from April 15 through June 6, 1983, when women more than 6 months or 26 weeks pregnant were eligible).
- Planned to move out of the immediate area before they delivered their babies.
- Reported an income exceeding 185 percent of the poverty level.
- Previously applied for or were certified for WIC for this pregnancy.

Children were selected to take part in the study from the group of natural (not adopted or foster) children living in each mother's household. Their selection was based on the following:

- If one child was between the ages of 0 and 4 years (up to but not including 5 years old), that child was designated the sample child.

- If two or more children were under 5 years of age, one was selected using a series of random numbers provided for each interview case.

- Once the sample child was selected, any other children over 4 years of age but not yet 6 were interviewed and the psychological component was administered to them.

To restate the selection in other terms, children under 5 years of age could be included only as sample children, if selected. Children 5 years of age (not yet 6) could be included only if a sample child (less than 5 years of age) was in the household. Children 4 years of age were eligible to be selected as sample children or could be included as other study children, if another child under 5 was selected as the sample child. Children 6 or older were never included in the sample.

Obtaining Cooperation

It was essential that the Initial Interview take place before any effects of the WIC program (or, among control women, of initial prenatal care) might influence either the Dietary Recall or responses to other questions. Prompt cooperation and compliance with the study were therefore important. It was critical for the field operatives to be able to explain the study well, answer questions completely and factually, and in some cases convince eligible women to sign the consent form. Unlike many other studies, it was almost impossible for other interviewers or supervisors to call on a woman to convince her to take part in the study. In the followup phase, more emphasis was placed on additional calls to convert refusals. However, during the followup phase, the biggest noninterview problem encountered was that of finding the extremely mobile and younger faction of the sample. If they could be found, they were usually very cooperative and willing to continue their participation.

A separate consent was necessary before the child could take part in the Study of Infants and Children. Since it was not necessary to complete this component on the day the woman was enrolled in the study, it was possible for supervisors to be more directly involved in the conversion of refusals (when women did not want to have their child/children participate). Most of the conversion attempts were conducted by telephone but were not very forceful, since the mother's future participation also was in jeopardy.

Obtaining cooperation for the WIC voucher issuance data collection was not a problem, but there was a question of participation from the hospitals asked to take part in the birth outcome abstractions. Some of the hospitals were concerned with the economics of completing the request. They balked at the reimbursement schedule ($3.00 per record abstraction) or

the allocation of personnel necessary to complete the task. Most concerns were addressed adequately, and an acceptable response was received during the time period allowed for completion.

Interview Components and Special Procedures

The components of the Initial Interview were:

Consent Form: A Consent Form was prepared and read to each eligible woman prior to any further involvement in the study. This form, when signed, fulfilled informed-consent legal requirements.

24-Hour Dietary Recall Interview: The respondent's recall of foods and beverages consumed during the previous 24 hours was documented on the day of their initial WIC site/clinic visit. This was done for a sample of 75 percent of the eligible women. A specially designed set of containers, container models, and food models were used to help respondents remember quantities of foods consumed.

Initial Questionnaire: This questionnaire included questions on the following topics: the respondent's current pregnancy, previous pregnancies and live births, background information on the respondent and the father of the baby she expected, household income, family food expenditures, and locator information.

Household Roster and Sample Child Selection: A roster of the respondent's natural children plus all other household members was prepared. If the respondent had any children under 5 years of age, one was selected as the "sample child." If a "sample child" was selected, data were collected about the child and any other natural children who were 4 or 5 years old.

Authorization Form: Each woman was asked to sign a form that authorized the facility where she planned to deliver her baby to release medical record data about the delivery and the newborn.

Women's Measurement Form: Certain body measurements were required for all women at the time of their entry to the study. The results of the measurements were recorded on this form. Specially designed and prepared equipment was used for height measurement. Scales and special equipment for measuring skinfold thickness also were made available and used in this component.

For the Followup Interview, the 24-Hour Dietary Recall Interview and the Women's Measurement Form were included to obtain comparable data. In addition, the Followup Questionnaire consisted of questions about prenatal care, the woman's health during her pregnancy, experience and advice about nutrition and infant feeding methods, housing characteristics, occupations, receipt of WIC services, and family food expenditures. In addition, a subsample of 1,615 women (approximately 50 percent WIC and 50 percent non-WIC) maintained a diary of food purchases for the 7-day period after the day of the Followup Interview. This document, called the Record of Your Daily Food Costs, was used to record all food purchases made by family unit members during the time period. It was accompanied by the Diary Placement and Pick-up Questionnaire, which was used by the field operative to document completion procedures used by the household respondent.

Child Interview components depended on the age and selection status (sample or other eligible) of the child. If the selected sample child was less than 4 years old, the components of the interview were then:

Child Consent Form: A Consent Form was prepared for the selected child or other sample child and was read to and signed by the mother before the child's further involvement in the study. The signed form fulfilled the informed-consent legal requirements.

24-Hour Dietary Recall Interview: The mother recalled the foods and beverages consumed by the child in the 24-hour period prior to the interview. If the interview was conducted outside of the clinic, it was usually conducted within 48 hours of the mother's interview. As with the women's Dietary Recall Interview, the specially designed models were used to help respondents remember quantities consumed.

Child Health Questionnaire: This portion of the interview contained questions about the child's health, use of health care services, certain diseases of interest, and a history of immunizations.

Child Measurement Form: In addition to a record of the child's father's estimated height, this form included a record of the child's weight, height or length, head circumference, left arm circumference, left triceps skinfold thickness, and left subscapular skinfold thickness as measured by the operative. A special height measurement device, skin fold measurement calipers, accurate tapes, and scientifically accurate scales were used in homes to measure children.

If the selected sample child was 4 years of age, four additional components were added to the interview. They were:

Peabody Picture Vocabulary Test: The Peabody Picture Vocabulary Test was administered as a rough measurement of intelligence for English speaking children. It consists of the child's identifying a picture from a spoken word stimulus.

Numerical Memory Test: The McCarthy Scales Numerical Memory Test was also used as a rough measurement of intelligence for English speaking children. It consists of the child's repeating a sequence of numbers in the order or in the opposite order that they are heard.

Behavior Inventory: This listing of examples of child behavior is designed to be self-administered by the mother. The mother identifies the example behaviors as being "Not at all like," "Very little like," "Somewhat like," or "Very much like" the way the child in question behaves all or most of the time.

Interviewer Rating of Maternal Behavior: This rating, completed by the operative interviewer immediately after leaving the interview, was a subjective record of the mother's behavior as observed by the operative. It includes observations about the mother's level of cooperation, responsiveness to the child's needs, and interest in the child's test performance.

All of the eight components listed applied to all other eligible children (4-year-olds not selected as the sample child and all 5-year-olds).

In the WIC voucher issuance data collection document the data items included:

- Each woman's WIC certification data, including each woman's reason for certification and each woman's certification priority code.

- Dates that food instruments were issued.

- Number of food instruments issued on each visit.

- Types and amounts of foods prescribed in each instrument.

All of the items were abstracted from one to three different records available at the WIC clinic where the woman was enrolled in the study, a central recordkeeping location, a records storage location, or some combination of the three.

Included in the birth outcome data were specific items regarding the outcome of the study pregnancy. These items consisted of:

- Details of prenatal visits.

- Indications of substance use or abuse.

- Notations of abnormalities of the pregnancy.

- Details of the delivery record.

- Details of the infant record.

The majority of the birth outcome data were collected through mailings to the hospitals of delivery. A small number of hospitals sent copies of their records to RTI for abstraction, and an even smaller number requested RTI personnel to visit and abstract or copy records. All hospitals attempted to collect information about their procedures for weighing and taking other measurements of newborn infants. This information was important to determine the comparability of data collected about the infants on the hospital records abstractions.

3. <u>Quality Control</u>

Several methods were used to ensure the collection of quality data by field operatives. These included:

- Two field edits conducted on each data collection document by the field operative responsible for the collection.

- Callbacks by the field operatives to the respondents by telephone or in person to rectify errors detected.

- Detailed edits conducted by field supervisors on at least the first two cases completed by each field operative at the beginning of each interview period.

- Feedback to each operative on the results of field supervisor edits.

- Recontact by telephone or mail of a 10-percent sample of each operative's interviews to confirm (verify) accurate collection and recording of data items.

- Generation of in-house edit error reports and feedback of the problems noted through field supervisors to the operatives on a weekly basis.

- Callbacks to the respondents by telephone to rectify errors in key items detected during the in-house edit.

- Completion of replicate anthropometric measurements on a selected subsample of interviews each week.*

F. DATA RECEIPT AND CONTROL

1. Receipt Procedures

RTI used a computerized system to monitor cases received and the status of each case. (This monitoring system is discussed in more detail in a later subsection of this chapter.) In order for the monitoring system to be effective, the data receipt staff had to prepare cases for event keying as soon as they arrived at RTI. As cases were received, they were sorted into one of several categories by case type. The categories used in the Initial Interview data collection period included:

- Completed Women's Interview Package.

- Completed Women's Interview Package with one or more Children's Interview Packages.

- Completed Nonresponse Package.

- Incomplete (problem) packages.

Categories used in the Followup Interview data collection period depended upon whether the case was a completed Women's Interview Package with or without a Diary, a complete nonresponse case, or an incomplete problem case.

After cases were sorted into appropriate categories, they were batched by type of case. Each batch was assigned a batch number and an event code, which was a two-digit number that indicated the type of cases contained within the batch. The batch number, event code, and WIC identification numbers of the cases in the batch were then event keyed. The batch was then sent to the editing staff for manual edit, or if it was an incomplete problem batch, it was placed on the problem shelf to await problem resolution.

2. Edit Procedures

A staff of approximately six editors was responsible for conducting a manual edit of each completed interview package received at RTI. The

---

*An analysis of the replicate measurements can be found in Volume V, Instrumentation.

manual edit was conducted through a set of prescribed edit steps that were outlined in the Data Receipt Procedures Manual. The edit procedures outlined in the manual were formatted as follows:

STEP	Specified the actual edit procedure.
ROUTING	Specified the next appropriate step when the instrument passed the edit step requirements.
PROBLEM	Specified possible problems and procedures for resolving the problem or, if the editor could not resolve the problem, procedural instructions for documenting the problem on a Problem Sheet and the appropriate routing of the package for problem resolution.

The first edit check made on completed interview cases was to make sure that an identification label was affixed to the cover of the interview package and that the identification number on the label was entered on all documents associated with the case. Then the case was checked to verify that all required survey instruments were included in the package. A review of certain key items in each instrument and a check to verify that measurements had been recorded in the correct format were conducted on each case. Editors were also required to make certain that measurements were within a specific range according to the woman's or child's height and/or weight.

If a problem was detected in the manual edit, the editor documented the problem on a Problem Reporting Form. All problem cases were routed to the Data Receipt Coordinator where the problem was resolved. If key item data were missing, the Coordinator completed a Key Item Edit Sheet and then sent the case to the Telephone Survey Unit where trained telephone interviewers contacted the sample woman to retrieve the missing data.

During the first 2 weeks of each edit phase (Initial Interviews and Followup Interviews), a 100-percent reedit was conducted on the first two batches completed by each editor. If both batches passed the reedit, the quality control of each editor's work was reduced to a 10-percent sample of completed work. For each two batches edited (five cases/batch), one case was pulled for a reedit. A set of random numbers was used to select the case to be reedited.

3. Coding Procedures

A staff of dietary coders with a background in foods or nutrition was trained and was responsible for editing and coding the items included in the 24-Hour Dietary Recall Interview section of the Initial, Followup, and Child Interview Packages.

The dietary coders followed edit procedures and coding steps that were outlined in the WIC Dietary Coding Manual. Entries in the 24-Hour Dietary

Recall section were checked for correct recording conventions and legibility. Foods listed in the "Other, Specify" sections (i.e., foods that did not fit into one of the precoded food spaces listed) were coded based on the Manual of Food Codes and conversion of measures to gram-weight. Coders were also responsible for checking to make sure that the amount of each food eaten was entered in the "Total Amount" column and that the total amount of each food consumed was calculated correctly. If problems were detected with the edit or if an item could not be coded, the coders completed a Dietary Problem Sheet and notified the Coding Task Leader of the problem. The batch that included the interview package was placed in a problem shelf until the case containing the problem was resolved.

A subsample of the women who participated in the Followup Interview completed the "Record of Your Daily Food Costs," also known simply as the Diary. Some of the data receipt editors were trained to edit and code this particular survey instrument following written edit and coding instructions. The edit of the Diary consisted of coding relationships of people who lived in the household during the time the Diary was completed, checking to make sure that entries were legible, and, for each entry, checking to make sure that an entry was made to indicate the preparation status of the food at the time of purchase. A four-digit food code was then assigned to each food listed in the Diary.

4. Control and Storage

The Data Receipt Coordinator maintained a manual log to monitor batches as they moved from one phase of data edit and processing to another. If a case was needed for review by a project staff member, the reviewer had to sign for the entire batch rather than check out the case he or she needed. This control measure enabled the Data Receipt Coordinator to maintain the integrity of each batch. If a batch was removed from the data receipt work area before it had undergone all data processing steps, the date it was removed and the name of the person who removed the batch were entered in the Batch Control Log. The date the batch was returned was entered when the batch was returned. This procedure was repeated until after the forms were processed completely, at which time these forms were logged out to controlled access storage.

All processed batches are stored in RTI's secure Document and Control Unit. If a case is needed for review after it is stored, the reviewer must sign and date a Document Control Batch Removal List and sign the batch in when it is returned.

G. DATA PROCESSING

Data processing for The National WIC Evaluation was a series of integrated tasks that (1) provided support to the data collection task through preparation of assignment control forms and monitoring of data received and processed and (2) converted data collected into machine-readable, edited, and cleaned data files for delivery to The National WIC Evaluation Team in New York (NYSRF) and FNS.

1. <u>Implementation and Maintenance of the Control System</u>

For The National WIC Evaluation, RTI utilized a software package for survey monitoring (SUMISS) that has been developed, tested, and utilized on many large surveys and data collection projects over the past 10 years. SUMISS was developed as a generalized package that could be tailored effectively to the specific requirements of any survey data collection and data processing operation. The purpose of the WIC Evaluation Control System was threefold:

- To maintain data on the WIC women participants and provide information to field operations for data collection activities.

- To monitor the receipt and data processing of each WIC data collection instrument.

- To provide final participant history information required for reconciliation of the database and construction of weights for nonresponse adjustments.

The control system was tailored to monitor all forms and cases to be received from the operatives. Events were developed that allowed appropriate reports to be produced for field operations, data receipt, and data processing management. Procedures were devised to review those reports after each control system update for reconciliation and determination of possible errors in data processing steps. During Time 1, the control system was run at the completion of each week. After the weekly updates were made, new reports for all the appropriate monitoring steps were produced. During Time 2, the control system updates and reports were done on a biweekly schedule.

The control system was designed to receive information from the field reporting system (a computer-assisted telephone interview [CATI] collection system) to initiate each woman's record in the control system. The control system maintained a record for each eligible woman and updated the status changes of each participant.

In summary, the control system was important for assigning cases and monitoring returned cases from the field. It was vital for documenting receipt of all forms from the field; for tracking all forms from the data receipt, editing, and coding functions through data entry transmission to the database at the mainframe computer; and for final construction of the data files and weights.

2. <u>Data Entry</u>

Data entry was on RTI's in-house VAX computers through an enhanced version of the programming language "Easy Entry." General rules and procedures applicable to all data entry projects were utilized. The consistency coding used clearly distinguishes blank fields from other possible interpretations of blank items such as zero or not known. A complete set of

consistency codes for other missing data such as "don't know" and "refused" was utilized.

In addition to these general procedures, the WIC project defined a detailed set of edits to be performed on each data item at the time of entry. These specifications were documented in the data entry programs and codebooks for each instrument.

3. Transmission of Keyed Data to the Database

After the data entry process, keyed data were transmitted to the mainframe computer for all subsequent processing. The data tapes copied from the VAX computer were transferred through the RTI transmission software for the subsequent processing steps of reorganization and machine edit. The RTI transmission step performed several functions:

- Creation of backup tapes for the raw data entry files.
- Checking for form integrity.
- Checking for duplicate forms.
- Creation of data files for quality control.
- Creation of data files for input to reorganization step.

4. Reorganization of Raw Data into Usable Format

The purpose of the reorganization step was to reformat the raw keyed data into files more appropriate and efficient for use in subsequent processing steps. The data entry program was written to ensure keying ease and accuracy and therefore was an image of the hard-copy document. The resulting file did not necessarily have portions of the document (i.e., Pregnancy History) in the desired order until after it had been processed by the program REORG.

Due to the variability within the WIC forms, it was inefficient to create one record to represent each document. Instead, a document was split apart into several files, each representing a fixed segment of the document. REORG also attached to the front of each record a fixed portion of the record called the "HEADER" containing identification and linkage information to allow matching and linking of records for a respondent.

The segments created from the WIC data were organized into fixed formats and represented a logical breakdown of the original documents. Each segment has its own codebook and is self-contained; it thus may be edited or analyzed separately or may be merged with other segments for processing.

5. Machine Edit Using RTI Software

The RTI Edit Package is a set of programs run by machine-readable codebooks and input card datasets that conduct range, consistency, and skip pattern checks on the data for a given document. The edit software saves error files for later use in producing error reports, creates output files ready for further processing, and produces backup files of edited data. The Edit Package was executed for each output dataset from the reorganization step; hence, edits were performed on one segment type at a time. First, the dataset for a document was sorted by segment type identifier. The main edit program then processed each segment type, using various subroutines to execute the checks. Once a segment had been processed, an error record was written to an error file. This process was repeated for each segment type in a document.

At the conclusion of the edit runs, an edited dataset for each document was ready for further database construction steps, backup files were made, and the error files were used as input to generate reports of error types detected by machine edit for each variable.

6. Special Machine Edits for Selected Data

Custom software was developed to perform machine edits on 24-Hour Dietary Recall and anthropometric measurement data. The dietary information was edited to enable valid measurement values to be converted into grams and to ensure linkage to U.S. Department of Agriculture (USDA) nutrient value files. The anthropometric data passed through a special machine edit to detect out-of-range data. Out-of-range or error values for each group of data variables were reviewed and corrected when possible.

7. Database Construction, Documentation, and Delivery

After data were edited and cleaned as specified or as required by quality control standards, the process of building the deliverable files and creating appropriate documentation was the final data processing step.

First, the data were verified to ensure that the appropriate persons were included. Consistency codes were utilized in all data items except those that were required, such as numerical identifiers. These consistency codes were used to explain nondata entries in data spaces such as "IL"/"92" to indicate an illegible entry or "DK"/"94" to indicate a "don't know" entry. Likewise, in the next step when confidential data (names, addresses, telephone numbers, etc.) were removed, indicator values also were substituted so that analysts would know what type of data had been removed.

RTI's standard documentation of file contents was a codebook that contains each variable name (label), description, length, range (character or numeric range), and file location. The codebook was provided in machine-readable form as the first label of each tape delivery and in hard copy as a part of the documentation delivery package.

In preparation for delivery, each file was processed with RTI software that creates SAS source code from the codebook described above. This SAS code was used to create frequencies of each variable (except identifiers). The process verifies that the codebook and the data file match and produces a set of frequencies for all variables on the deliverable file. A hard copy of those frequencies was provided as file documentation.

The File Delivery Package also contained, in addition to the tapes with codebook and data files, specific information about the tapes and any specific notes important to the contents of the files. Backup copies of all file deliveries made to NYSRF and to FNS are maintained at RTI.

H. DESCRIPTIVE CHARACTERISTICS OF THE STUDY SAMPLE

1. Clinics and Sites

A total of 373 clinics/sites (256 WIC and 117 non-WIC) were selected in the study sample. Of that total, 229 (174 WIC and 55 non-WIC) actually took part in the study. Taking part means that the clinic/site agreed to cooperate and that on at least one occasion the data collection staff attempted to enroll women in the study at the clinic/site. In several places study participants were never enrolled either because none were available or because the clinic/site closed before any eligible women visited.

The remaining 144 clinics/sites that never took part in the study (82 WIC and 62 non-WIC) can be categorized as follows:

Status codes	Status categories	WIC clinics	Non-WIC clinics	Totals
50	No prenatal treatment offered	7	11	18
51	Facility closed/not enrolling new patients	13	0	13
60 & 61	Refused participation	9	25	34
92	Other: out-of-sample	16*	24†	40
93	Dropped from sample	37	2	39‡
	Total nonparticipating clinics	82	62	144

*The 16 other: Out-of-sample WIC nonparticipants include three clinics identified as Indian WIC service locations, four clinics not located within the geographic boundaries of the PSUs, and nine clinics where initial enrollment of patients was accomplished at one of the other selected sample clinics in the PSU.

†The 24 other: Out-of-sample non-WIC nonparticipants include sites where WIC enrollment for qualified patients existed within the facility.

‡After sample selection, it was determined that these 39 clinics/sites could not be covered in an economical manner and that the expected yield was not at a level to warrant their inclusion.

This section summarizes descriptive data collected on WIC and non-WIC sites included in the Longitudinal Study of Pregnant Women. The data describe the scope of clinic services, the extent of administrative support, and the nature of existing nutrition education services. Two instruments initially were sent to each site: an Administrator's Questionnaire and a Nutrition Education Questionnaire. The Health Site Administrator and Head Nutrition Educator both were asked to complete and return these instruments to RTI. Approximately 95 percent were completed and returned to RTI from the clinic sites, 97 percent (n = 169) from WIC sites and 87 percent (n = 47) from non-WIC sites. Later in the study an instrument to measure local WIC program quality and effectiveness was sent to State WIC Directors to rank each local program in which Longitudinal Study subjects were recruited. Twenty-two of 28 State WIC Directors completed and returned the instruments. For discussion, the data from these three instruments are presented in the next two sections on WIC site and non-WIC site responses. A third section summarizes and compares these two sets of data.

WIC Study Sites

One hundred and sixty-nine WIC sites in 26 States completed and returned both the WIC Site Administrator's Questionnaire and the Nutrition Education Questionnaire. Of these, 17 percent are neighborhood or community health agencies, 38.5 percent are county health agencies, and 22 percent are State or district health agencies. The median number of women served per month was 118 at these sites, the median number of pregnant women was 76, and the median number of postpartum or lactating women was 30. The median number of women reported as certified per month was 25, with 18 of these pregnant. Ninety-two percent of clinic sites reported that infants (under 1 year) and children (1 to 4 years) also were served. As reported in the discussion of field methodology, these estimates, particularly new certification estimates, were much larger than were actually found during the evaluation.

Most sites (about 72 percent) reported that 95 to 100 percent of all program applicants were eligible to receive benefits and that most of these sites (60 percent) usually certified women the same day they applied for benefits. For those placed on waiting lists, an average waiting period of 2.4 weeks was reported. Almost 89 percent of all surveyed sites reported using instruments such as checks or vouchers as the food supplement system. Thirteen percent reported using home food delivery (several sites reported using both systems), while only 3.5 percent (six sites) reported using a food distribution system.

Only three sites (1.78 percent) reported that they mailed food vouchers to pregnant women, while 69 percent reported that they permitted proxy pickup of food instruments. Almost the same percentage (71 percent) reported that 1-month intervals were used to disperse these instruments, while 73 percent reported that specific days or periods were set aside to disperse food instruments.

Two-thirds of the WIC sites surveyed reported that pregnant women usually returned on a monthly basis after their initial visit, even though only 3.5 percent of these sites provided transportation and only 6 percent arranged for onsite child care. On the other hand, 51 percent reported that onsite prenatal care services were provided and 56 percent reported regular arrangements with facilities to provide prenatal care services. Sixty-four percent of all WIC sites reported capillary samples (finger-stick) as the normal procedure for obtaining blood samples from women to test for anemia. This level of use demonstrates the preparedness of WIC sites to test quickly for anemia as a potential criterion for program entry. This is confirmed by the fact that over 62 percent of these sites reported that results of the hemoglobin or hematocrit tests were usually available during the initial visit. Likewise, about 85 percent of all sites reported having a beam balance scale for weighing applicants and program participants.

Of all the sites, 50 percent reported the presence of Spanish speaking participants and 7 percent (12 sites) reported that at least 50 percent of their clientele spoke Spanish. Similarly, over one-third of all WIC survey sites (about 37 percent) reported the presence of Vietnamese participants.

The average WIC site enrolled in the Longitudinal Study had four full-time staff paid in full with WIC funds. Sites reporting part-time staff supported with WIC funds (64 sites) had an average of two additional part-time employees present. Forty-nine percent of all WIC survey sites reported the presence of a full-time nutritionist or a dietitian, and 36 percent of all sites reported the presence of a part-time nutritionist or dietitian (some sites had both full-time and part-time). On the other hand, only one site reported supporting a full-time physician with WIC funds, and three sites reported supporting a part-time physician. Consistent with WIC's mandate to serve those with greatest need, one-third of all sites had staff who spoke Spanish and 5.5 percent of the sites had staff who spoke Vietnamese.

A set of questions was developed to explore the issue of staff turnover rates in order to assess site working conditions and morale. Fifty-two percent of all WIC sites reported that at least one staff member resigned, retired, or was terminated during 1982. Forty percent reported staff leaving voluntarily, and 8 percent reported firing staff. Conversely, 13 percent of the WIC sites reported establishing new staff positions, and about 58.5 percent reported hiring new staff during 1982.

Nutrition educators of responding WIC survey sites reported that almost 92 percent of all sites ensured that 100 percent of their pregnant participants received nutrition education. In addition, pregnant women were estimated to receive nutrition education counseling approximately four times during their pregnancy. All but one site reported using one-to-one counseling as a means of nutrition education, with 73 percent using this method most often. Ninety-six percent reported having written nutrition education plans, guidelines, or instructions for use with pregnant women. Slightly fewer (94 percent) reported having similar materials for breast-feeding women and for infant and children under 5 years. Eighty percent

had developed materials for postpartum (not breastfeeding) women as well. Subject topics receiving most attention by WIC clinics included (in descending order of emphasis): nutritional requirements during pregnancy, breastfeeding, nutritional requirements during infancy, infant feeding practices and weaning, general nutrition and nutrients, and nutritional requirements during childhood and child feeding practices.

While almost all WIC sites (98 percent) reported providing information or advice on infant feeding methods, 53 percent most often recommend breastfeeding as the preferred method of infant feeding. Over 79 percent of the nutrition educators surveyed indicated that written materials or audiovisual materials were available in Spanish and about 29 percent offered staff presentations or advice in Spanish. Vietnamese materials were reported available in 57 percent of the sites, and 7 percent of the sites offered staff presentation or advice in Vietnamese.

About 4.4 staff members were estimated to be available for nutrition education services at WIC sites, with 74 percent reporting the presence of a nutritionist and 16 percent reporting the presence of a dietitian. Almost three-quarters of the responding nutrition educators reported that factors limited their ability to provide nutrition education or advice including (in descending order of importance) lack of available time with patients, budget constraints, lack of staff, and lack of space in the facility.

Twenty-two of 28 State WIC Directors completed and returned instruments to assess the quality and effectiveness of local WIC programs. Assessments were available for 135 of 174 programs under study. (Results were not returned from three very large urban States, which include three of the five largest metropolitan areas in the country.) Thus, for example, data in the analysis on duration of gestation were available for 3,137 initial WIC women, and of these, there was a WIC program ranking for 2,045 women. WIC program ranking data were analyzed in relation to selected maternal and newborn outcomes and are reported accordingly in Chapter V.

Non-WIC Study Sites

Forty-seven non-WIC sites in nine States completed the Administrator's Questionnaire. Approximately two-thirds of these sites were public or private hospitals, and another 10.6 percent (five sites) were neighborhood or community health agencies. Over 91 percent of these sites served Medicaid-eligible patients, underscoring the similar low-income populations served by the WIC and non-WIC sites.

The median number of pregnant women beginning prenatal services per month was estimated to be 26, with 18 of these believed to be Medicaid or low-income patients. Fifty-one percent reported charging for prenatal services on a sliding-fee scale.

The procedures used to obtain the first blood sample from pregnant women to test for anemia (and presumably other tests) was overwhelmingly

venipuncture (81 percent). About 64 percent of the non-WIC sites also reported that results from the blood sample were not available until 1 or more days after the initial visit. All but one of the non-WIC sites reported having a beam balance scale for weighing adults.

Thirty-five sites (74.5 percent) reported having patients who spoke Spanish as their principal language, and 8.5 percent reported that at least half of their patient population spoke Spanish as their first language. Fifty-one percent reported the presence of Vietnamese patients in their clinic population.

Fifty-three percent of the survey sites reported full-time physicians in their employ and working in the prenatal clinic. Seventeen percent of the non-WIC sites reported that a full-time nutritionist or dietitian was employed, and about 28 percent reported the presence of a part-time nutritionist or dietitian. About 72 percent of all non-WIC sites had staff who spoke Spanish and 11 percent who spoke Vietnamese.

Clinic administrators were questioned regarding annual staff turnover in 1982, the year preceding the survey. Almost 47 percent reported staff members who resigned, retired, or were terminated. Thirty-four percent of the sites reported employees who voluntarily resigned, and only one site (about 2 percent of our sample) reported firing an employee. On the other hand, over 55 percent added new staff in 1982, with 21 percent reporting newly established positions, and 40 percent reporting replacing staff who left.

The responding non-WIC nutrition educators reported that nutrition education or advice was provided in all but two of the non-WIC sites. Fifty-one percent of the sites reported providing routinely vitamin/mineral supplements to pregnant patients. Fifty percent of the non-WIC sites reported providing nutrition education or advice to 100 percent of their prenatal patient population, with the average pregnant woman receiving nutrition education about 3.6 times during her pregnancy.

Eighty-nine percent of the non-WIC sites reported providing one-to-one counseling, with over 69 percent using this method most often. Group discussions/seminars/classes were reported as used in 52 percent of the clinics, and 22 percent used this approach most often. Non-WIC survey sites reported having written nutrition education plans, guidelines, or instructions for pregnant women in 85 percent of the sites, for breastfeeding women in 78 percent of the sites, for postpartum (not breastfeeding) women in 46 percent of the sites, and for infants and children under 5 years in 87 percent of the sites.

The topic most frequently reported as discussed during nutrition education sessions was nutritional requirements during pregnancy. Most non-WIC sites (89 percent) provided information on infant feeding practices, and 37 percent encouraged breastfeeding.

Seventy-four percent of the non-WIC sites reported having written or audiovisual materials in Spanish, and 11 percent reported similar materials available in Vietnamese. Oral presentations or advice was provided in Spanish at 41 percent of the sites and in Vietnamese at about 7 percent of the sites.

Non-WIC sites reported having, on average, 4.4 staff members employed to provide nutrition education or advice, and 28 percent reported employing a nutritionist or a dietitian. Sixty-five percent of the sites reported factors that limited their ability to provide nutrition education or advice, including (in descending order of importance): lack of available time with patients, lack of staff, lack of space in the facility, and budget constraints.

Comparison and Conclusions

While both WIC and non-WIC survey sites served low-income, Medicaid-eligible populations, there were several administrative and service differences between the two sets of sites. First, over three times as many WIC (n = 169) as non-WIC (n = 47) sites responded to the Administrator's and Nutrition Education Questionnaires, consistent with the sampling strategy and the goal to create a nationally representative sample of the WIC program. Most of the local WIC programs were sponsored by neighborhood, community, county, State, or district health agencies (77.5 percent), whereas the majority of non-WIC sites were public and private hospitals (67 percent). Table IV-2 details the full range of sponsoring agencies for both sets of sites.

Table IV-2

Type of Agency or Organizations Sponsoring Clinics by WIC/Non-WIC Sites

	WIC (%)	Non-WIC (%)
Neighborhood/community health agency	17	11
Community action agency	6	0
Municipal health agency	4	4
County health agency	38	4
State or district health agency	22	2
Indian health agency	0	0
Public hospital	2	15
Private voluntary hospital	1	51
Private proprietary hospital	4	2
Other	5	6
No response	2	4
	101[a]	99[a]

[a] [illegible] equal to 100 percent due to rounding.

WIC and non-WIC sites reported that they generally enrolled the same number of new low-income prenatal and non-WIC patients each month, a median of 18 per month. The procedures for obtaining the first blood sample from pregnant women to test for anemia varied between the two sets of sites and reflected the different purposes for which the tests were used. At WIC sites, anemia tests are potential criteria for program entry. As such, quick and efficient methods must be used; in fact, 64 percent of WIC sites report using capillary samples (fingerstick) as the normal procedure for obtaining blood samples, and almost all of these sites also reported that results of this technique were usually available during the initial visit. This differs from the non-WIC survey sites, where 81 percent used venipuncture as the primary method of obtaining the first blood sample from pregnant women. One must presume that this larger volume of blood is used in a battery of tests, not just to test for anemia, particularly in hospital settings. Consequently, about 64 percent of these sites also reported that results were not available until 1 or more days after the initial visit.

Both WIC and non-WIC sites reported sizable proportions of their prenatal patient population whose primary languages were other than English (Table IV-3). At WIC sites, 50 percent reported the presence of Spanish speaking participants, with 7 percent of the sites reporting 50 percent or more of their clientele speaking Spanish. At the non-WIC sites, 74.5 percent reported Spanish speaking clients present, with 8.5 percent of these sites having patient populations with at least half speaking Spanish. The degree to which Vietnamese were present in both sets of sites was unexpected. About 37 percent of WIC sites and 51 percent of non-WIC sites reported Vietnamese prenatal patients.

Table IV-3

Percentage of Sites Reporting Clients Speaking Other Languages
by Language by WIC/Non-WIC Sites

	WIC sites (%)	Non-WIC sites (%)
Chinese	5	6
French	7	9
German	0	4
Italian	0	6
Portuguese	0	2
Spanish	50	77
Vietnamese	37	51

Table IV-4

Percentage of Sites Reporting Staff Turnover by 'Type' of Turnover by WIC/Non-WIC Sites

	WIC sites (%)	Non-WIC sites (%)
Voluntary resignation	40	36
Retirement	8	4
Transfer out of WIC site (clinic)	14	15
Layoff/reduction in force	5	2
Fired	8	2
Other	9	4

Questions to clinic administrators regarding annual staff turnover during 1982 elicited similar responses (see Table IV-4). At WIC sites, 52 percent reported that at least one staff member resigned, retired, or was terminated during 1982. At non-WIC sites, the figure was 47 percent. WIC sites more often reported firing staff (8 percent) than non-WIC sites (2 percent) did, and both sets (WIC and non-WIC) were successful in creating new positions (13 percent versus 21 percent) and replacing staff who left (51.5 percent versus 40 percent).

More of the non-WIC sites reported having staff who spoke Spanish (74 percent) and Vietnamese (13 percent) than the WIC sites (33 and 5 percent, respectively). Table IV-5 displays the proportion of sites where clinic staff speak foreign languages. This is consistent with the language demands on the two sets of sites because the non-WIC sites generally had

Table IV-5

Percentage of Sites with Staff Speaking Other Languages by Language by WIC/Non-WIC Sites

	WIC sites (%)	Non-WIC sites (%)
Chinese	2	4
French	5	15
German	2	9
Italian	4	4
Portuguese	2	4
Spanish	33	74
Vietnamese	5	13

more patients speaking languages other than English. Despite this fact, however, WIC sites more often had written and audiovisual materials available in Spanish (79 percent) and Vietnamese (57 percent) than non-WIC sites did (74 and 11 percent, respectively).

The response to the Nutrition Education Questionnaire demonstrated some clear differences between WIC and non-WIC sites. For example, WIC sites reported the employment of nutritionists and dietitians in 74 percent and 16 percent of the sites, respectively, while non-WIC sites reported 28 percent with either a nutritionist or dietitian. On the other hand, only one WIC site reported employing a physician with WIC funds, while 53 percent of the non-WIC sites reported full-time physicians. Similarly, 92 percent of the WIC sites reported that 100 percent of their prenatal participants received nutrition education compared to 50 percent in the non-WIC sites. More WIC sites reported having written nutrition education plans, guidelines, or instructions for their patients than non-WIC sites did. Methods of providing nutrition education or advice varied less. WIC sites provided one-to-one counseling, as the preferred method, about as much as the non-WIC sites (72 percent vs. 69 percent) did. Table IV-6 displays the different types of presentations used and which methods were used most often by WIC and non-WIC sites.

Nutrition education topics receiving attention by clinic staff were often similar at WIC and non-WIC sites, although WIC sites placed more emphasis on breastfeeding as the preferred method of infant feeding (53 percent vs. 37 percent) and on infant nutritional requirements and weaning

Table IV-6

Percentage of Sites Using Different Types of Presentations and Types Used Most Often by WIC/Non-WIC Sites

	WIC sites		Non-WIC sites	
	Method used (%)	Method used most often (%)	Method used (%)	Method used most often (%)
Oral presentation method				
One-to-one counseling	99	72	89	69
Group discussions/seminars/classes	76	25	52	22
Written or visual materials				
Audiovisual presentation	83	11	54	11
Written materials	99	76	91	78

Table IV-7

Percentage of Sites Reporting Nutrition Education on Different Topics by WIC Sites/Non-WIC Sites by Level of Emphasis

	WIC sites				Non-WIC sites			
	Not included (%)	Little emphasis (%)	Some emphasis (%)	Much emphasis (%)	Not included (%)	Little emphasis (%)	Some emphasis (%)	Much emphasis (%)
General nutrition and nutrients	0	4	14	82	0	2	22	67
Nutritional requirements during pregnancy	0	0	4	96	0	0	13	78
Specific diets for complications of pregnancy (diabetes, hypertension, anemia, etc.)	2	14	48	36	13	0	39	39
Postpartum nutrition and weight control	2	21	57	19	4	24	48	13
Nutritional requirements during infancy	1	2	11	85	13	17	28	28
Infant feeding practices and weaning	1	2	12	84	13	17	24	33
Nutritional requirements during childhood and child feeding practices	3	4	17	74	22	30	26	9
Pica	16	53	23	7	26	26	22	4
Smoking during pregnancy	2	8	40	49	4	7	26	52
Alcohol consumption during pregnancy	2	8	42	49	0	4	30	54
Substance abuse (marijuana, sedatives, etc.)	4	18	49	28	4	9	33	43
Breastfeeding	0	1	8	91	2	4	22	61
Importance of regular health care	0	4	34	61	0	9	26	54
Food purchasing, preparation, and storage (shopping hints, budget advice, etc.)	2	20	56	23	11	22	39	13

practices. Table IV-7 displays the percentage of sites reporting nutrition education of different topics by level of emphasis.

2. Survey Respondents

This section summarizes statistics on completion of the various important data collection components that comprised the field studies. Table IV-8 presents completion statistics for women and children at Time 1, for women at Time 2, and for WIC women only and infants (birth outcomes) during voucher issuance and hospital record abstraction, respectively. The following items should be noted:

Table IV-8

Field Data Collection Completion Statistics

Data collection component	Number attempted[a]			Number completed			Percent completed		
	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total
Time 1									
Women's Initial Package	6,317	1,717	8,037	5,205	1,358	6,563	82.39	79.09	81.65
Child's Package	2,188	528	2,723	2,165	454	2,619	98.84	85.98	96.18
Special Followup Supplement	*	*	*	302	25	327	*	*	*
Time 2									
Women's Followup Package	4,884	1,333	6,217	3,967	1,043	5,010	81.22	78.24	80.58
Diary (record of your daily food costs)	922	850	1,772	853	762	1,615	91.52	89.64	91.13
Diary Placement and Pick-up Questionnaire	922	850	1,772	922	850	1,772	100.00	100.00	100.00
Other									
WIC Voucher Issuance Form	5,204	**	5,204	5,026	**	5,026	96.57	**	96.57
Hospital records abstract (Birth outcome data)	*	*	6,553	3,863[b]	1,058[b]	4,921[b]	*	*	75.09[b]

[a]Does not include the ineligible cases identified.

[b]Includes only cases where birth outcome data were returned. An additional 541 cases were returned by hospitals indicating that no record of the patient visit could be found. If these additional cases were included as complete, the total number completed would be 5,462 and the resulting percent completed 83.35.

*Number not available/calculation incomplete.

**Does not apply.

- The Children's Package counts at Time 1 include not only sample children but also the additional children eligible and interviewed from each household.

- The Diary completion at Time 2 was limited to a subsample of each group (WIC vs. non-WIC) of respondents. The sample was designated in such a way to yield completion of at least 750 respondents in each subsample.

- Diary Placement and Pick-Up Questionnaires were used to document nonresponse to the Diary.

- Birth record abstractions were attempted for all women who had signed an authorization form. Some of the women who signed the forms subsequently refused to complete or completed only a portion of one or both of the interviews.

Table IV-9 supplements Table IV-8 by presenting an explanation of the nonresponse for the data collection components. The incomplete portion for

Table IV-9

Field Data Collection Nonresponse Statistics

Data collection component	Percent incomplete	Reasons for nonresponse
Time 1		
Women's Initial Package	18.35	.40 = Physically/mentally incapable
		2.01 = Language barrier
		1.62 = Breakoff/incomplete data collected
		4.41 = Refused
		7.61 = Unable to contact on the day of enrollment
		2.30 = Other (primary category = needed approval from husband or parent)
Child's Package	3.82	.69 = Breakoff/incomplete data collected
		1.56 = Refused
		1.57 = Other (primary category = child not available)
Time 2		
Women's Followup Package	19.42	.27 = Physically/mentally incapable
		3.61 = Moved out of sample area
		11.95 = Delivered before interview
		.18 = Breakoff/incomplete data collected
		1.45 = Refused
		1.96 = Other (primary category = could not find)
Diary (record of your daily food costs)	8.87	.50 = No one capable
		.01 = Language barrier
		3.76 = Refused
		4.60 = Other (primary categories = placed but not picked up and subsample response reached before completion)
Other		
WIC Voucher Issuance Form	3.43	3.43 = Record of the woman could not be located
Hospital records abstract (birth outcome data)	24.91	8.26 = Hospital could not find record of woman
		6.82 = Blank form returned-no explanation given
		9.78 = Form not returned in time for processing
		.05 = Form completion refused by hospital

each item is presented by percentages and reasons for nonresponse. The nonresponse reason "other" is presented, and the primary category within the classification is noted in parentheses.

This section also includes a visual presentation of the field contacts with respondents. Figure IV-1 presents an overall picture of the field protocol from initial screening through Time 1 interviews with women and children, Time 2 interviews with women, the voucher issuance data collection for WIC women, and finally the hospital record abstraction phase. Statistics also are presented by WIC vs. non-WIC, where available.

Figures IV-2, IV-3, and IV-4 present additional information about the makeup of the women's samples during the Time 1, Time 2, and hospital record abstraction phases. Specifically, these three special presentations include the completion statistics in reference to the collection of dietary data. Only 75 percent of women were asked to complete the 24-Hour Dietary Recall portion of the interview. Figure IV-2 shows the number of WIC vs. non-WIC Time 1 women who were and were not interviewed by their status as included or excluded from the dietary subsample. The same information is provided in Figure IV-3 for the Time 2 women. Similar information is presented in Figure IV-4. However, this description relates to the breakdown of hospital record abstraction (birth outcome) data. In this figure, the important result is a tally of the number of birth outcomes completed for the number of women for whom dietary recall information is available.

A description of the characteristics of the sample women is presented in the next section on comparability of samples.

I. COMPARABILITY OF WIC AND CONTROL GROUPS

1. Sociodemographic Factors

Introduction

This section describes the distributions of several sociodemographic characteristics across study groups for the entire group of women enrolled in the study, depending on whether they were WIC recipients or controls, and for the subset of women for whom information on birth was available. The characteristics of control women who had enrolled in the WIC program by followup visit also are compared with those of residual control women.

The strength of inference that can be drawn from a study depends on many issues, such as the comprehensiveness and reliability of measurement. None, however, is more important than the comparability of the study and control populations. If they are not comparable, while secure inference on program effect is by no means precluded, the results must be interpreted with special caution. For instance, if controls are more privileged, observed WIC benefits may be underestimates and true program benefits may be obscured. If controls are at greater health risk or of lower social status than those enrolled in the WIC program, comparisons might yield results that indicate program benefits but that in reality have little to do with the WIC program.

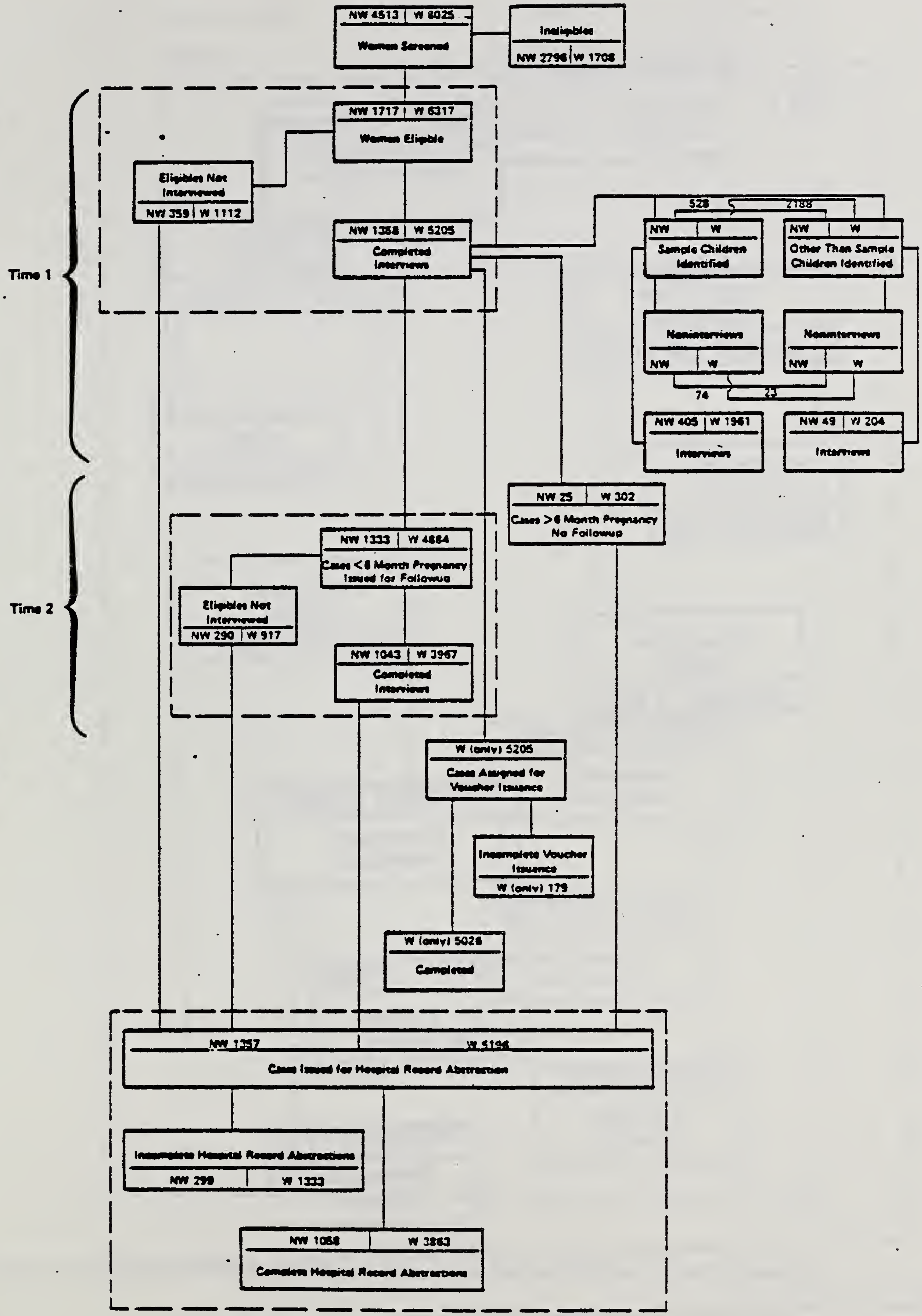


Figure IV-1. Field protocol and completion by time period.

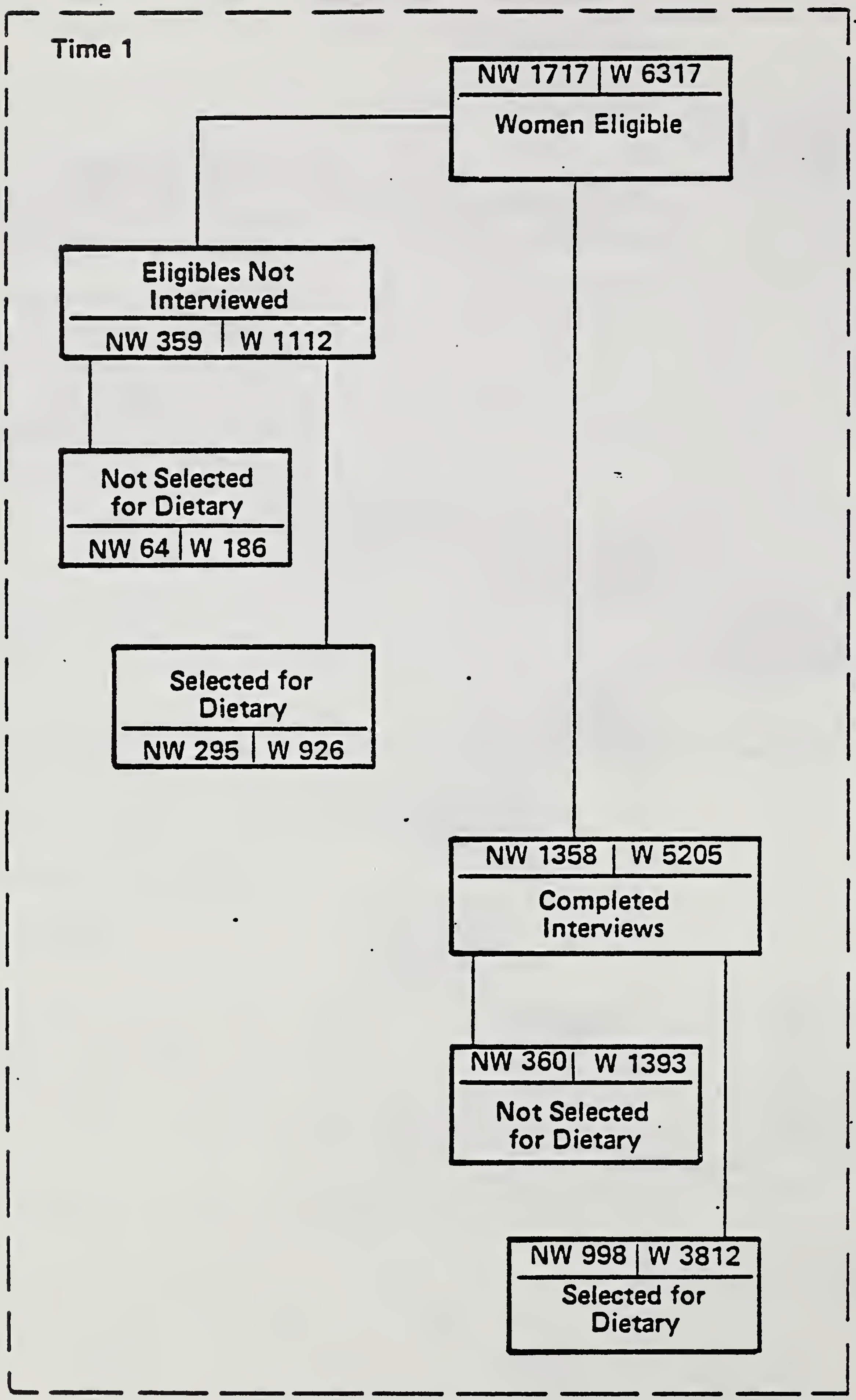


Figure IV-2. Women's time 1 completion by 24-hour dietary recall subsample.

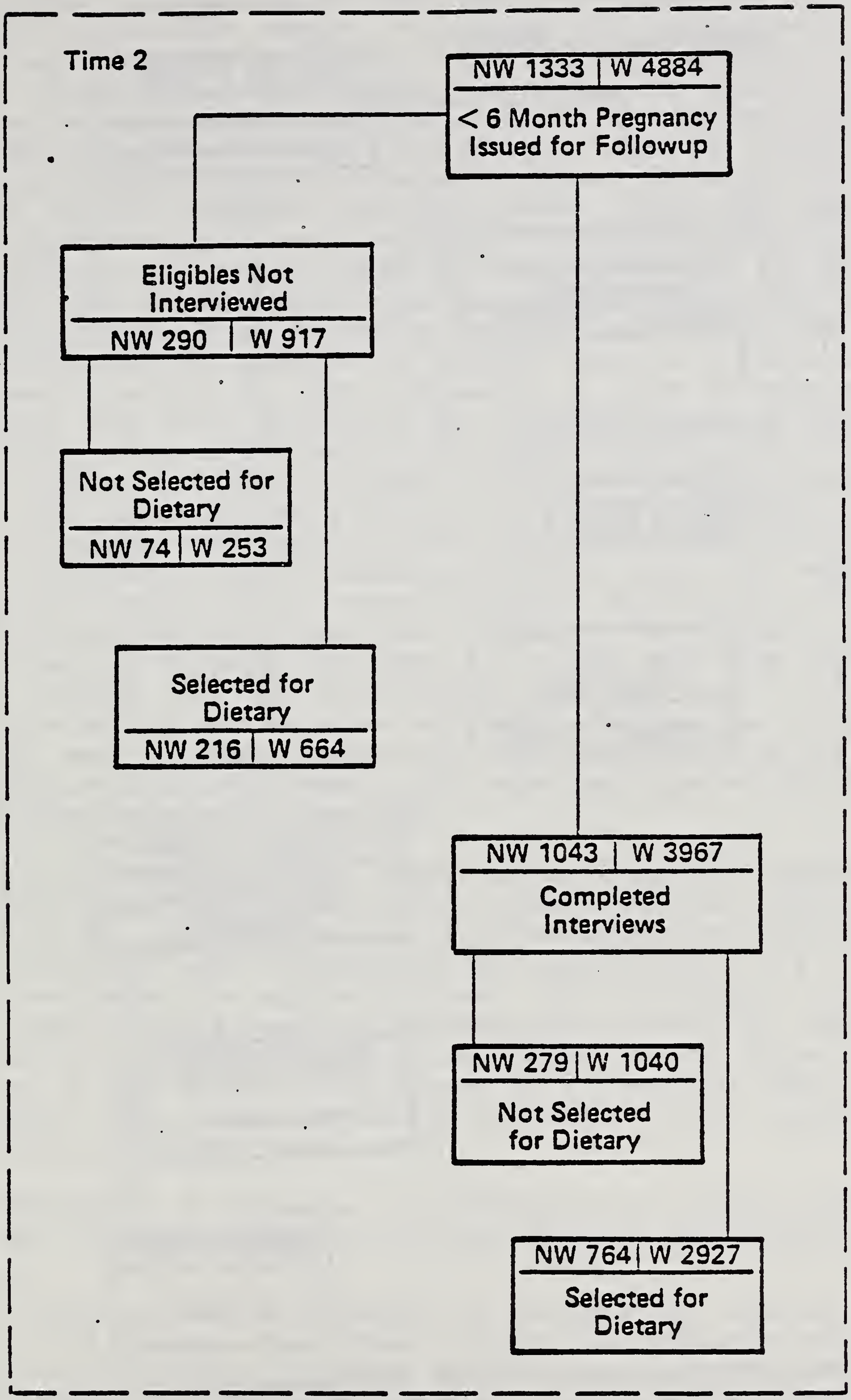


Figure IV-3. Women's time 2 field completion by 24-hour dietary recall subsample.

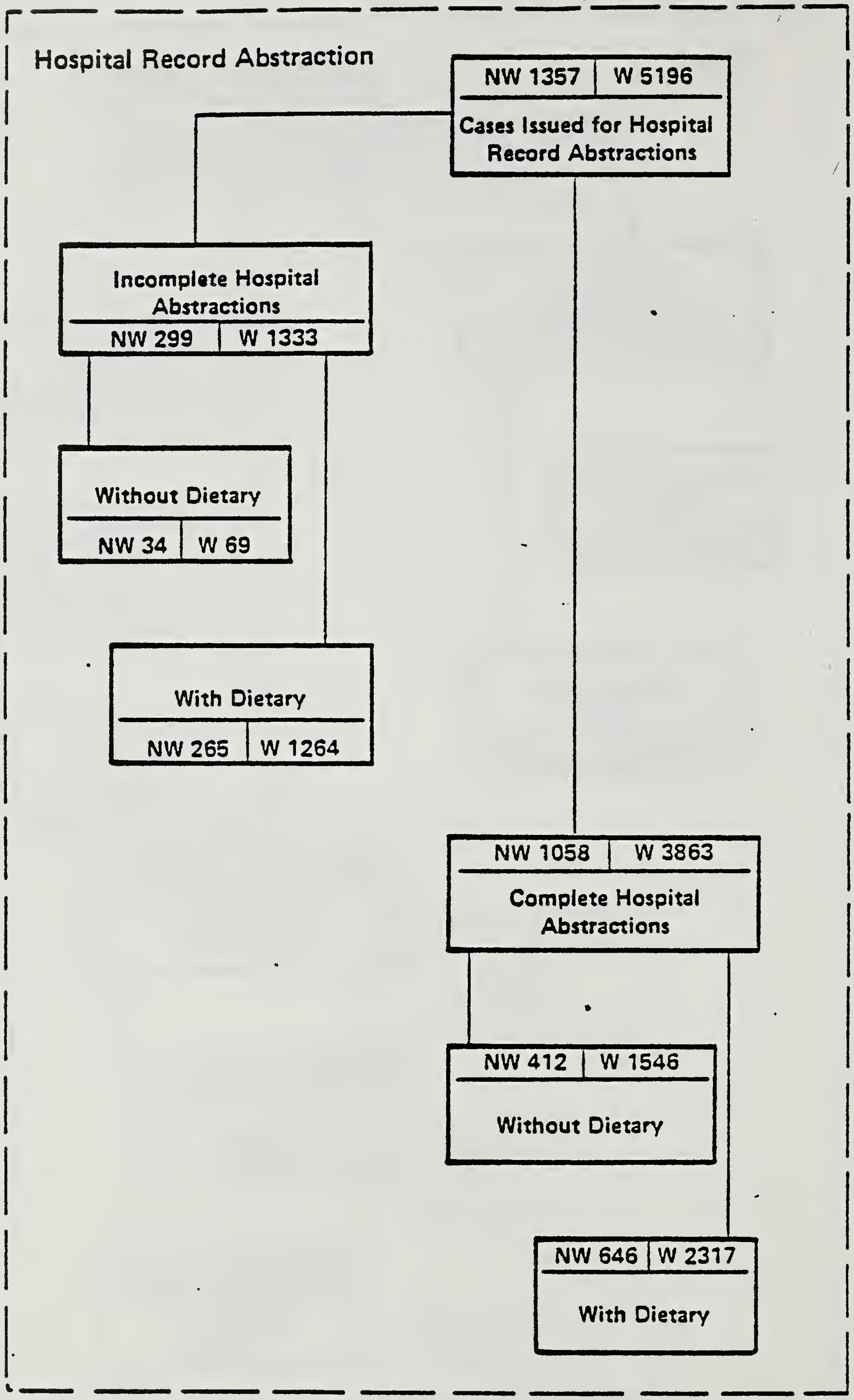


Figure IV-4. Hospital record abstractions by 24-hour dietary recall subsample.

Women initially recruited into the WIC study group were a nationally representative probability sample of pregnant WIC participants; control women, although recruited nationwide, were not a probability sample but rather were drawn from public health department or hospital prenatal clinics, from the same randomly selected areas.* As discussed earlier, WIC recipients were enrolled at 1 of 174 WIC delivery sites and controls at one of 55 public or hospital prenatal clinics throughout the continental United States in 58 randomly selected geographic areas. (The PSUs were single counties or groups of contiguous counties.) A woman was enrolled in the WIC sample only if she had not been certified previously for WIC during this pregnancy and if she did not plan to move more than 1 hour's travel time or, alternatively, 45 miles from her current residence before delivering. A control woman was enrolled if she met specific criteria including no prior prenatal visits for this pregnancy, no plans to move more than 1 hour's travel time or 45 miles from her residence before delivering, no prior application or certification for WIC benefits during this pregnancy,† and the same income criterion applicable to WIC participants under Federal guidelines. The original study protocol also excluded women who were more than 6 months pregnant (196 days) at WIC enrollment or entry into prenatal care. After 10 weeks of data collection, the study sample was smaller than expected and the proportion of women ineligible due to late duration of gestation at enrollment was larger than originally anticipated. Thus, it was decided partway through the study to broaden the study eligibility criteria to include both WIC and control women who were 7 or 8 months pregnant. Five hundred and seventeen such women, or 8 percent of the final study sample, were ultimately recruited. (All analyses of birth outcomes in this report exclude these women.) The enrollment period for all study women lasted from February to June 1983.

An à priori assumption that control group women were comparable to those in the WIC group was not made. For instance, control women could not be enrolled if they received prenatal care from private practitioners, nor could the nutritional risk criteria for WIC certification (i.e., criteria other than low income) be applied to them. The WIC program is now widespread and fewer eligible women are unserved than heretofore. By 1980, an estimated one-third of all pregnant women eligible by the income criterion were enrolled in the program (see Chapter III, Historical Study of Pregnancy Outcomes). Thus, women not served were likely to be, in general, at lower nutritional risk than those served.

The credibility of estimates of differences in outcome between WIC recipients and controls depends on at least moderate comparability between

---

*Indian WIC agencies and the 6 percent of smallest WIC agencies were excluded from the sample, the former because the subsample of recruits would have been too small to assess whether there were differential effects among Indians and the latter because of the very high costs of their inclusion in the study.

†She was retained in the study if she subsequently enrolled in the WIC program.

participants and controls, especially where there appears to be no program effect, or even adverse program effect, and the ability to adjust in analysis for identifiable differences between study groups in risk characteristics associated with outcome. Such adjustment in analysis for different frequencies of risk factors across study group, while statistically feasible, is inherently limited by the ability to first identify and then accurately measure variables that distinguish WIC participants from controls which might affect outcome. Stronger inference can be drawn if the study groups are initially comparable than if statistical adjustment procedures are used.

It is important and probably worth reiterating that the possible effects of noncomparability can, in part, be inferred from the results and that such effects are of different consequence depending on whether the control group is at greater or lesser risk of adverse outcome than were WIC recipients. If control women were at greater risk, observed group differences might be falsely attributed to the program. This is not the case, since the results suggest that the controls were at lower risk. Thus, estimated program benefits are likely to be conservative and not due to confounding by initial noncomparability of cases and controls. On the other hand, real program benefits may be obscured by such noncomparability.

Analysis

This section compares the sociodemographic status of WIC participants and control women. Factors under study include maternal ethnicity; marital status; receipt of Medicaid, Aid to Families With Dependent Children (AFDC), and Food Stamps; family income; parental education; occupational status; and current work patterns (see Table IV-10). WIC status was defined in three ways:

- By initial study status: initial controls (n = 1,458) vs. the initial WIC sample (n = 5,205).
- For women for whom perinatal outcome data were available by initial study status (825 initial controls and 2,662 initial WIC recruits).
- For initial controls who returned for late pregnancy followup, depending upon whether they subsequently had been enrolled in WIC (n = 262) or not (n = 781).

Where appropriate, significance was tested by a chi-square test.

Results for Pregnant Women

In general, the distribution of maternal characteristics for the subset of women with available perinatal data was nearly identical to that for the entire study population. This discussion therefore refers to the latter comparisons, unless otherwise specified.

Table IV-10

Social and Demographic Factors and Whether Recruited by WIC Control Status

Sociodemographic characteristics	All study recruits Status at recruitment		Women with known perinatal outcome Status at recruitment		All initial controls with late followup status	
	WIC	Control	WIC	Control	WIC/Control	Control
Ethnicity						
White non-Hispanic	48.2	50.4	48.7	50.7	40.1	56.1
White Hispanic	15.9	23.9	13.6	23.1	30.9	20.7
Black	33.3	21.6	34.9	21.6	24.4	19.6
Other	2.7	4.1	2.7	4.7	4.6	3.6
	$\chi^2 = 96.57$, $p = 0.0001$		$\chi^2 = 103.32$, $p = 0.0001$		$\chi^2 = 21.08$, $p = 0.0001$	
AFDC and Food Stamps						
Nonparticipant	52.6	70.3	50.9	71.7	65.7	72.7
AFDC	3.4	2.1	3.8	2.1	0.8	2.4
Food Stamps	28.3	21.3	28.2	20.0	22.5	20.2
AFDC and Food Stamps	15.8	6.4	17.1	6.2	11.1	4.6
	$\chi^2 = 153.91$, $p = 0.0001$		$\chi^2 = 159.32$, $p = 0.0001$		$\chi^2 = 17.73$, $p = 0.0001$	
Married	43.7	52.8	44.8	54.5	50.4	56.0
	$\chi^2 = 35.97$, $p = 0.0001$		$\chi^2 = 30.90$, $p = 0.0001$		χ^2 = n.s.	
Father present in household	51.1	60.8	51.6	61.8	59.5	63.8
	$\chi^2 = 39.54$, $p = 0.0001$		$\chi^2 = 34.11$, $p = 0.0001$		χ^2 = n.s.	
AFDC	19.2	8.5	20.9	8.3	11.8	7.0
	$\chi^2 = 86.64$, $p = 0.0001$		$\chi^2 = 87.84$, $p = 0.0001$		$\chi^2 = 5.33$, $p < 0.05$	
Medicaid	23.4	25.0	24.6	23.7	28.2	24.1
	χ^2 = n.s.		χ^2 = n.s.		χ^2 = n.s.	

(continued)

Table IV-10 (continued)

Sociodemographic characteristics	All study recruits Status at recruitment		Women with known perinatal outcome Status at recruitment		All initial controls with late followup status	
	WIC	Control	WIC	Control	WIC/Control	Control
Mother's education (yr)						
<12	55.0	48.0	53.9	46.7	42.1	59.9
12	34.1	38.4	35.1	39.1	42.6	29.4
12+	10.9	13.6	11.0	14.2	15.2	10.7
	$\chi^2 = 22.27$, $p = 0.0001$		$\chi^2 = 18.98$, $p = 0.0001$		$\chi^2 = 24.98$, $p = 0.0001$	
Mother's occupational status						
Farm worker	2.1	0.4	2.2	0.3	0.0	0.4
Physical work/service/manufacturing	46.7	43.2	46.1	43.2	47.7	43.4
Skilled trade/office work/sales	22.9	31.8	23.7	32.6	26.0	33.9
Professional	3.3	4.5	3.4	5.1	5.3	4.7
Never worked	25.0	20.2	24.7	18.8	21.0	17.5
	$\chi^2 = 71.26$, $p = 0.0001$		$\chi^2 = 62.53$, $p = 0.0001$		χ^2 = n.s.	
Mother's employment status						
Employed	14.5	20.8	14.5	21.9	20.6	21.5
Unemployed	28.1	21.4	28.3	20.8	22.1	21.0
Housewife/student/disabled	57.4	57.9	57.2	57.3	57.3	57.5
	$\chi^2 = 44.58$, $p = 0.0001$		$\chi^2 = 46.18$, $p = 0.0001$		χ^2 = n.s.	
Income ($/100)						
<3,000	16.3	10.8	16.0	10.1	12.2	9.6
3,000 - 6,999	31.8	26.0	32.3	25.5	33.6	22.3
7,000 - 12,999	25.6	34.3	25.7	35.2	28.2	39.4
13,000 +	9.9	12.6	10.4	14.1	11.8	14.0
Missing	16.4	16.4	15.7	15.2	14.1	14.7
	$\chi^2 = 71.29$, $p = 0.0001$		$\chi^2 = 69.84$, $p = 0.0001$		$\chi^2 = 18.71$, $p = 0.0009$	

(continued)

Table IV-10 (continued)

Sociodemographic characteristics	All study recruits Status at recruitment		Women with known perinatal outcome Status at recruitment		All initial controls with late followup status	
	WIC	Control	WIC	Control	WIC/Control	Control
Father's education (yr)[a]						
<12	36.3	34.7	36.5	34.8	40.6	31.8
12	38.4	40.0	38.5	40.3	34.9	43.8
>12	9.9	12.2	9.7	12.2	13.2	11.3
Missing	15.4	13.1	15.3	12.7	11.3	13.1
	χ^2 = n.s.		χ^2 = n.s.		χ^2 = n.s.	
	2543	533	1861	402	106	283
Father's education (yr)[b]						
<12	47.3	40.9	45.4	38.9	49.4	37.8
12	37.7	39.4	39.1	39.5	32.1	42.0
>12	12.4	17.1	12.8	19.1	14.1	18.1
Missing	2.6	2.7	2.7	2.6	4.5	2.2
	$\chi^2 = 16.22$, $p = 0.0001$		$\chi^2 = 17.98$, $p = 0.0001$		$\chi^2 = 10.23$, $p < 0.05$	
	2662	825	1987	651	156	498
Father's occupational status[a]						
Farm worker	3.2	1.5	3.1	1.5	1.9	0.7
Physical work/service/manufacturing	47.5	47.8	48.2	47.3	43.4	50.5
Skilled trade/office work/sales	14.7	18.4	13.8	18.9	22.6	18.7
Professional	3.8	5.4	3.8	5.0	4.7	5.7
Never worked	30.9	26.8	31.2	27.4	27.4	24.4
	$\chi^2 = 13.55$, $p < 0.01$		$\chi^2 = 11.76$, $p < 0.05$		χ^2 = n.s.	
	2543	533	1861	402	106	283

(continued)

Table IV-10 (continued)

Sociodemographic characteristics	All study recruits Status at recruitment		Women with known perinatal outcome Status at recruitment		All initial controls with late followup status	
	WIC	Control	WIC	Control	WIC/Control	Control
Father's occupational status[b]						
Farm worker	7.7	1.6	7.9	1.8	0.6	2.0
Physical work/service/manufacturing	61.8	56.0	61.5	54.2	63.5	53.4
Skilled trade/office work/sales	21.3	28.1	21.2	30.3	21.8	29.5
Professional	4.0	7.9	4.2	8.5	5.8	9.2
Never worked	5.2	6.4	5.2	5.2	8.3	5.8
	$\chi^2 = 75.08$, $p = 0.0001$		$\chi^2 = 65.95$, $p = 0.0001$		χ^2 = n.s.	
	2662	825	1987	651	156	498
Father's employment status[a]						
Employed	40.4	44.1	39.5	44.8	38.7	47.0
Unemployed	31.9	29.5	32.6	28.4	41.5	26.9
Retired/in jail/deceased/disabled	27.8	26.5	27.9	26.9	19.8	26.2
	χ^2 = n.s.		χ^2 = n.s.		$\chi^2 = 7.83$, $p < 0.05$	
	2543	533	1861	402	106	283
Father's employment status[b]						
Employed	53.0	64.6	53.7	65.8	54.5	67.7
Unemployed	42.1	30.9	41.4	29.8	41.7	27.1
Retired/in jail/deceased/disabled	4.9	4.5	4.9	4.5	3.9	5.2
	$\chi^2 = 35.36$, $p = 0.0001$		$\chi^2 = 29.83$, $p = 0.0001$		$\chi^2 = 11.89$, $p < 0.01$	
	2662	825	1987	651	156	498
Total n (except where otherwise noted)	5,205	1,358	3,848	1,053	262	781

[a]Father not living in household.

[b]Father living in household.

Ethnicity. Considerably more black women were in the WIC group (33.3 percent vs. 21.6 percent in the control group, $p < 0.001$). Conversely, the proportion of Hispanics was much higher in the control group. Controls who joined the WIC program between initial and followup visits were more likely to be Hispanic or black than white.

Marital Status and Presence of Father in the Household. Women were asked their current marital status and whether they were currently living with the father of the unborn child. Controls were more likely to be married (52.8 percent vs. 43.7 percent of the WIC group, $p < 0.001$) and to be living with the father of the child (60.8 percent vs. 51.1 percent, $p < 0.001$).

Aid to Families with Dependent Children (AFDC). Twenty and two-tenths percent of the initial WIC sample received AFDC vs. 8.5 percent of controls ($p < 0.001$). The frequency of AFDC receipt among controls who later joined the WIC program was intermediate (11.8 percent).

Medicaid. The rate of Medicaid receipt was nearly identical in the initial WIC and control groups (23.4 and 25.0 percent, respectively). (This finding suggests that studies of perinatal outcome that have used Medicaid roles as a sampling frame and that assumed all Medicaid recipients are of comparable social and economic status must be viewed with caution.)

Food Stamps. Forty-four percent of the initial WIC sample received Food Stamps vs. 27.7 percent of initial controls ($p < 0.001$). The rate among initial controls who later received WIC was intermediate (33.6 percent).

Educational Attainment of the Woman and Father of the Child. Controls were better educated than were WIC recipients (48.0 percent of controls vs. 55.0 percent of WIC recipients had fewer than 12 years of education). Among the 53 percent of mothers who were living with their infants' fathers, the educational attainment of the fathers of WIC sample infants was lower than in the control group (47.3 percent with under 12 years of schooling vs. 40.9 percent, $p < 0.001$).

Occupational Status of Parents. In general, control women worked in higher status occupations than women in the WIC sample did. For instance, 31.8 percent of control women worked in skilled trades, office work, and sales vs. 22.9 percent in the WIC group ($p < 0.001$). Spouses of controls also had slightly higher status occupations.

Current Employment Status. Control group women were more often employed (20.8 percent vs. 14.5 percent of WIC women, $p < 0.001$). Control group fathers also were more often employed (64.6 percent vs. 53.0 percent in the WIC group).

Family Income. The family income of control group women was higher than of women in the WIC group (10.8 percent of control women were from families with a yearly income under $3,000 vs. 16.3 percent in the WIC group, $p < 0.001$).

Military Families and Women Living in States in which the WIC Criterion was Below 185 Percent of Federally Defined Poverty Level

Food and Nutrition Service (FNS) staff suggested two possible sources of the social disparity between families of WIC recipients and controls. First, several prenatal clinics where control women were recruited were on military bases and these women might not be comparable to WIC recipients. Second, in some States the upper income level for WIC eligibility is below the federally mandated upper limit of 185 percent of the federally defined poverty level, while controls recruited into the study in those States were not required to have lower income than other controls in the study (i.e., 185 percent of the poverty level). The study of preschool children assessed whether inclusion of the military in the control group and the income criterion had distorted the analyses.

Control group families recruited from States with lower WIC income eligibility criteria than the federally set maximum had lower incomes than other controls had. That possibility was therefore not pursued further. The effect of recruiting women in military families as controls was assessed.

Living on a Military Base. On military bases, 151 control group women were recruited and none in the WIC group. Of 907 control women with known birth outcome, 109 or 12.0 percent were recruited from military base clinics. They had significantly longer duration of gestation than did other controls (6.0 days [p = 0.006] in the partially adjusted and 5.0 days [p = 0.04] in the fully adjusted regression analyses), and their infants' birthweights were 122 grams higher than other controls in the partially adjusted analysis (p = 0.04) and 65 grams higher than other controls in the fully adjusted model (p = 0.29, n.s.).

Because of this, all basic analyses including those on maternal anthropometric change in pregnancy and those relating maternal WIC benefits to perinatal outcome excluded women recruited in the military prenatal clinics.

Controls from Areas Where WIC Income Eligibility was Below 185 Percent of Federally Defined Poverty Levels. The WIC control disparity in income arose entirely from areas where the income eligibility criterion was 185 percent, not from areas where the criterion was below 185 percent. Therefore, the controls from the latter areas were retained in the analysis, since they were not the source of WIC control bias. This issue was not pursued further.

2. Biomedical Factors: Maternal Age and Reproductive History

Introduction

This section compares the age and eight indices of past reproductive history of control women and women recruited into the initial WIC Study group. The indices are the proportion of primiparous women and the mean

Table IV-11

Maternal Age and Reproductive History by WIC or Control Status

Biomedical factors	All study recruits: WIC	All study recruits: Control	Women with known perinatal outcome: WIC	Women with known perinatal outcome: Control	All initial controls with known status at followup: WIC/Control	All initial controls with known status at followup: Control
All women						
Mean age	22.23 t = -2.42	22.60 p = 0.02	22.19 t = -2.73	22.61 p = 0.006	22.53 t = 0.48	22.70 n.s.
Mean number of previous births	0.99 t = 2.70	0.89 p = 0.007	0.99 t = 2.14	0.90 p = 0.03	0.90 t = -0.38	0.87 n.s.
Primiparous (%)	44.9 χ^2 = 1.64	46.9 n.s.	44.3 χ^2 = 1.79	46.6 n.s.	48.1 χ^2 = 0.06	47.0 n.s.
n	5,205	1,358	3,848	1,053	262	781
Multiparous						
Previous birth with birthweight ≤2,500 g (%)	21.6 χ^2 = 3.87	18.8 p = 0.049	20.9 χ^2 = 2.52	17.8 n.s.	17.7 χ^2 = 0.01	16.9 n.s.
Previous neonatal death (%)	1.2 χ^2 = 1.63	0.6 n.s.	1.2 χ^2 = 0.61	0.7 n.s.	0.5 χ^2 = 0.11	0.7 n.s.
n	2,867	721	2,145	562	136	414
Multigravid						
Previous tubal pregnancy (%)	1.0 χ^2 = 0.23	0.8 n.s.	1.0 χ^2 = 0.28	0.7 n.s.	1.1 χ^2 = 0.00	0.8 n.s.
Previous miscarriage (%)	25.7 χ^2 = 0.53	24.4 n.s.	25.5 χ^2 = 0.02	25.2 n.s.	22.2 χ^2 = 0.18	24.1 n.s.
Previous induced abortion (%)	21.5 χ^2 = 6.34	25.4 p = 0.01	20.5 χ^2 = 5.70	24.8 p = 0.02	28.4 χ^2 = 1.17	23.9 n.s.
Previous stillbirth (%)	2.6 χ^2 = 0.92	1.9 n.s.	2.5 χ^2 = 1.14	1.6 n.s.	2.2 χ^2 = 0.44	1.0 n.s.
n	3,448	908	2,557	706	176	518

number of previous births among multigravid women, whether they had ever had an induced abortion, miscarriage, stillbirth, or tubal pregnancy, and among multiparous women, whether they had ever had a low-birthweight infant or an infant who died in the neonatal period. These indices are compared in three different ways: among all initial study recruits; among women for whom abstracts of hospital delivery records were available; and, among initial controls, between those who later entered the WIC program and residual controls. Results are presented in Table IV-11.

Characteristics and Comparability of Initial Study Sample

Four indices significantly differentiated initial WIC study recruits' and control women. Women in the WIC group were younger (22.2 vs. 22.6 years, $p < 0.05$); were of higher parity (1.0 vs. 0.9 live births, $p < 0.01$); were more likely to have had a previous low-birthweight infant

(among multiparous women, 21.6 percent vs. 18.8 percent, $p < 0.05$); and, among multigravid women, were less likely to have ever had an induced abortion (21.5 percent vs. 25.4 percent, $p < 0.05$). They also had higher rates of past tubal pregnancy, miscarriage, stillbirth, and of infants who died in the neonatal period, but none of these differences were significant. Thus, the WIC group, while younger, had a worse past reproductive history. On the other hand, these differences were of relatively small magnitude and were all statistically adjusted in analyses relating WIC program participation to maternal and perinatal outcome.

Characteristics and Comparability of Sample of Women for Whom Perinatal Outcome was Known

The characteristics of the subgroup of women for whom perinatal outcome was known were nearly identical to those of the total group of initial recruits. There was little or no evidence of selective loss from the initial study sample, based on these indices of past reproductive history.

Characteristics of Control Women who Enrolled in the WIC Program Between Initial Study Recruitment and Late Pregnancy Followup

While numbers were relatively small (262 control women who joined the WIC program and 781 residual controls at late pregnancy followup), with consequently weak tests of significance, none of the indices under study differed significantly depending on recruitment into the WIC program. Past reproductive history appears to have little relationship to the likelihood of recruitment into the WIC program among women who initially joined the study as controls.

Conclusion

These comparisons suggest little probability of major influence on the validity of estimates of WIC program enrollment on maternal or perinatal outcome that would not be amenable to statistical adjustment procedures.

3. Comparability of WIC and Control Groups in the Study of Infants and Children

Sociodemographic Characteristics

This subsection examines differences in various socioeconomic indices between children enrolled in the study of Infants and Children who were current and past recipients of the WIC program and those who were never enrolled in the program, stratified by whether or not their pregnant mothers were enrolled in WIC. Because these were children of mothers recruited in the Longitudinal Study of Pregnant Women, the same concerns for comparability apply.

Sociodemographic status including ethnicity, income, education, occupation, and marital status of the mother; Medicaid; AFDC; and receipt of

Food Stamps is compared for children currently receiving WIC benefits (n = 759), past recipients (n = 691), and children who were never enrolled in the program (n = 839). These three groups are stratified further by whether the mother was recruited into the WIC or control group (see Table IV-12). This grouping (currently enrolled in WIC, past recipients, or never enrolled) is that used in the analysis of dietary benefits (Chapter VI).

Where appropriate, significance was tested by a chi-square test.

Ethnicity. The proportion of blacks was considerably higher among children currently or previously in WIC than among controls. Thirty-five percent of children currently or previously in WIC were black, compared to 19.4 percent of control children (chi-square, ever WIC vs. never WIC = 58.78, $p < 0.001$). There was a weaker relationship with whether the mother was in the WIC or control group.

In contrast, the proportion of white Hispanics in the control group (21.8 percent) was somewhat higher than among children previously in WIC (17.7 percent) and much higher than among current recipients (10.8 percent) (chi-square, current vs. past vs. never WIC = 34.77, $p < 0.001$). There were many more Hispanic control mothers than Hispanic WIC mothers (28.0 vs. 14.6 percent) (chi-square, WIC mother vs. non-WIC mother = 41.22, $p < 0.001$).

Marital Status and Presence of Father in the Household. Women were asked their current marital status and whether they were currently living with the father of their unborn child. Control children were far more likely to have married mothers and fathers in the home. Fifty-six percent of mothers of children ever in WIC were married vs. 70 percent of mothers of control children (chi-square, ever WIC vs. never WIC = 45.94, $p < 0.001$), and 61 percent of children ever in WIC had fathers in the home vs. 74 percent of control children (chi-square, ever WIC vs. never WIC = 45.20, $p < 0.001$).

AFDC. Children who had ever received WIC benefits were more commonly in households that were current AFDC beneficiaries than control children (31 vs. 17 percent, chi-square = 49.21, $p < 0.001$). WIC mothers with control children were more likely to receive AFDC (22 percent) than control mothers with control children (10 percent).

Medicaid. Whether the child had ever received WIC benefits was strongly associated with current enrollment in Medicaid; mother's study status was less strongly related. One-third of the families of children currently receiving WIC, 26 percent of the families of children previously receiving WIC, and one-fifth of the families of control children were currently enrolled in Medicaid (chi-square, current vs. past vs. never WIC = 38.47, $p < 0.001$).

Table IV-12

WIC Status of Mother and Child by Social and Demographic Characteristics

	WIC status of child											
	Current			Past			Never			Total		
	Mother			Mother			Mother			Mother		
	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total
Ethnicity												
White non-Hispanic	56.2	44.7	55.6	42.9	32.9	41.8	55.2	52.3	54.2	51.6	48.0	50.9
White Hispanic	10.1	23.7	10.8	16.2	30.1	17.7	18.6	28.1	21.8	14.6	28.0	16.9
Black	32.3	31.6	32.3	37.9	31.5	37.2	21.1	16.1	19.4	30.9	20.4	29.1
Other	1.4	0	1.3	3.1	5.5	3.3	5.1	3.5	4.5	3.0	3.5	3.1
Marital status												
Married	57.4	65.8	57.8	51.0	69.9	52.9	65.5	78.6	69.9	57.6	75.7	60.8
Other	42.6	34.2	42.1	49.0	30.1	42.0	34.5	21.4	30.0	42.3	24.2	39.1
Father figure in home												
Present	60.9	71.1	61.3	57.4	78.1	59.6	70.4	82.5	74.4	62.5	80.5	65.6
Absent	39.1	29.0	38.6	42.6	21.9	40.3	29.6	17.5	25.5	37.4	19.4	34.3
Receipt of welfare (AFDC)												
Yes	31.5	31.6	31.5	30.9	23.3	30.1	21.5	9.5	17.4	28.3	14.1	25.9
No	68.5	68.4	68.5	69.1	76.7	69.8	78.5	90.5	82.5	71.6	85.8	74.0
Medicaid												
Yes	32.3	55.3	33.4	26.1	28.8	26.3	20.4	18.6	19.7	15.9	23.9	26.2
No	67.7	44.7	66.5	74.0	71.2	73.6	79.6	81.4	80.2	73.2	76.0	73.7
Receipt of Food Stamps												
Yes	60.7	63.2	60.9	52.4	42.5	51.4	41.2	24.2	35.4	52.3	31.3	48.7
No	39.3	36.8	39.1	47.6	57.5	48.6	58.8	75.8	64.6	47.7	68.7	51.3

(continued)

Table IV-12 (continued)

	WIC status of child											
	Current			Past			Never			Total		
	Mother			Mother			Mother			Mother		
	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total
Mother's education (yr)												
<12	55.6	55.3	55.6	53.6	49.3	53.1	46.0	42.5	44.8	52.1	44.9	50.9
12	38.1	34.2	37.9	35.0	38.4	35.3	36.6	37.2	36.8	36.7	37.1	36.7
>12	6.2	10.5	6.5	11.5	12.3	11.6	17.3	20.4	18.4	11.2	17.9	12.4
Father's education (yr)[a]												
<12	47.6	55.6	48.1	47.3	45.6	47.1	42.8	35.3	40.0	45.9	38.9	44.4
12	41.9	37.0	41.6	39.7	38.6	39.6	39.5	43.0	40.8	40.5	41.7	40.7
>12	10.5	7.4	10.3	13.0	15.8	13.3	17.7	21.7	19.2	13.6	19.4	14.8
Mother's occupational group												
Physical labor/ service/manufacturing	49.2	42.1	48.9	51.8	42.5	50.8	47.1	44.6	46.2	49.4	43.9	48.5
Farm laborer	2.2	0	2.1	3.2	0	2.9	2.0	0.7	1.5	2.5	0.5	2.1
Skilled trade/clerical work/sales	20.3	18.4	20.2	20.4	34.3	21.9	27.3	31.9	28.8	22.3	31.1	23.9
Professional	2.1	5.3	2.2	2.4	4.1	2.6	5.1	6.3	5.5	3.1	5.8	3.5
Never worked	26.2	34.2	26.6	22.2	19.2	21.9	18.6	16.5	17.9	22.7	18.7	22.0
Father's occupational group[a]												
Physical labor/ service/manufacturing	64.7	63.0	64.6	60.0	50.9	58.7	59.2	51.9	56.5	51.5	52.7	59.6
Farm laborer	10.3	0	9.7	6.8	3.5	6.3	6.2	2.1	4.6	7.9	2.2	6.7
Skilled trade/clerical work/sales	19.4	29.6	20.0	24.2	28.1	24.8	24.4	29.4	26.2	22.5	29.2	23.9

(continued)

Table IV-12 (continued)

	WIC status of child											
	Current			Past			Never			Total		
	Mother			Mother			Mother			Mother		
	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total	WIC	Non-WIC	Total
Father's occupational group[a] (continued)												
Professional	3.7	3.0	3.0	4.5	5.3	4.6	5.9	11.9	8.2	4.4	10.0	5.6
Never worked	2.7	3.7	2.8	4.5	12.3	5.6	4.4	4.7	4.5	3.5	6.0	4.3
Mother's employment status												
Employed	10.3	15.8	10.5	12.8	8.2	12.3	12.8	16.5	14.1	11.8	14.9	12.4
Unemployed/laid off	23.0	10.5	22.4	25.2	23.3	25.0	18.2	11.2	15.9	22.3	13.4	20.8
Other (housewife, student, disabled)	66.7	73.7	67.1	62.0	68.5	62.7	69.0	72.3	70.1	65.8	71.7	66.8
Father's employment status[a]												
Employed	58.3	40.7	57.3	53.0	66.7	54.9	52.6	75.7	61.3	54.8	71.2	58.3
Unemployed	36.5	48.2	37.1	42.3	24.6	39.8	43.6	21.3	35.2	40.5	24.1	37.1
Other (student, disabled)	5.2	11.1	5.6	4.8	8.8	5.3	3.9	3.0	3.5	4.6	4.7	4.7
Yearly income ($/100)												
<3,000	15.5	7.9	15.2	15.1	9.6	14.5	9.9	7.7	9.2	13.7	8.1	12.8
3,000-	36.9	36.8	36.9	37.2	32.9	36.8	31.2	24.6	29.0	35.3	27.3	33.9
7,000-	29.0	29.0	29.0	30.0	31.5	30.1	32.9	39.3	35.0	30.4	36.9	31.5
13,000-	8.0	15.8	8.4	9.6	13.7	10.0	16.4	18.3	17.0	11.0	17.2	12.1
Missing	10.5	10.5	10.5	8.3	12.3	8.7	9.6	10.2	9.8	9.5	10.6	9.7
n	(721)	(38)	(759)	(618)	(73)	(691)	(554)	(285)	(839)	(1,893)	(396)	(2,289)

[a] Analysis includes fathers who were reported to be living in the household. The number of subjects are given below.

N	(439)	(27)	(466)	(355)	(57)	(412)	(390)	(235)	(625)	(1,184)	(319)	(1,503)

Food Stamps. Households of children who currently or previously received WIC benefits were more commonly recipients of Food Stamps than households of control children (current WIC [61 percent] vs. past WIC [51 percent] vs. controls [35 percent], chi-square = 106.39, $p < 0.001$). Among mothers of control children, those in the WIC group were more likely than controls to be receiving Food Stamps (41 vs. 24 percent, chi-square = 22.91, $p < 0.001$).

Mother's and Father's Education. The parents of control children had more schooling than parents of WIC children. Eighteen percent of the mothers of control children completed more than 12 years of education, compared to 9 percent of mothers of children currently or previously receiving WIC (chi-square, ever WIC vs. never WIC = 43.07, $p < 0.001$). Fathers of control children had completed more years of schooling than fathers of WIC children had. Nineteen percent of the fathers of control children had completed more than 12 years of education. In contrast, 12 percent of fathers of children ever receiving WIC benefits completed more than 12 years of schooling (chi-square, ever WIC vs. never WIC = 15.57, $p < 0.001$). (These rates refer to fathers present in the household at the time of the study.)

Occupational Status of Parents. The parents of control children reported working in occupations that, in general, required more skill and education than parents of children currently or previously receiving WIC benefits. Six percent of mothers of children who had never received WIC benefits considered themselves professionals (working as managers, administrators, technical specialists, and in other white collar positions) compared to 2 percent of mothers of children ever receiving WIC benefits (chi-square, ever WIC vs. never WIC = 13.77, $p < 0.001$). Twenty-nine percent of mothers of control children had skilled trades, did clerical work, or were in sales, vs. 21 percent of mothers of children who currently or previously received WIC (chi-square, ever WIC vs. never WIC = 17.76, $p < 0.001$). The same trends were true for fathers present in the household.

Current Employment of Parents. Parents of control children, particularly mothers, were less likely to be unemployed than parents of children receiving WIC benefits. Only 16 percent of mothers of control children were currently unemployed or laid off vs. 24 percent of mothers whose children had ever received WIC (chi-square, ever WIC vs. never WIC = 19.20, $p < 0.001$).

Income. Total 1982 family income of households of control children was significantly higher than the income of households of children currently or previously in WIC. Only 9 percent of the mothers of control children said their families earned under $3,000 yearly, compared to 15 percent of mothers of current or previous WIC recipients (chi-square, ever WIC vs. never WIC = 14.74, $p < 0.001$). Similarly, 17 percent of families of control children had incomes of $13,000 or more compared to 9 percent of families of current and/or past WIC recipients (chi-square, ever WIC vs. never WIC = 30.26, $p < 0.001$). Families of control mothers with control

Table IV-13

WIC Status of Child by Social and Demographic Characteristics of Family for Families Living on a Military Base

	Child's WIC status (%)			
	Current	Past	Never	Total
Race				
White	100.0	66.7	80.7	79.5
Black	-	33.3	17.7	19.2
Other	-	-	1.6	1.4
Marital status				
Married	100.0	100.0	98.4	98.6
Other	-	-	1.6	1.4
Father in household				
Present	100.0	100.0	98.4	98.6
Absent	-	-	1.6	1.4
Current welfare (AFDC)				
Yes	100.0	100.0	100.0	100.0
No	-	-	-	-
Current Medicaid				
Yes	100.0	100.0	100.0	100.0
No	-	-	-	-
Mother's education (years)				
<12	-	55.6	17.7	21.9
12	50.0	33.3	51.6	49.3
>12	50.0	11.1	30.7	28.8
Mother's occupational group				
Physical labor/service/ manufacturing	-	66.7	35.5	38.4
Farm laborer	-	-	-	-
Skilled trade/clerical work/sales	50.0	22.2	46.8	43.8
Professional	50.0	-	11.3	11.0
Never worked	-	1.1	6.5	6.9
Mother's employment status				
Employed	100.0	11.1	17.7	19.2
Unemployed/laid off	-	-	-	-
Other (housewife, student, disabled)	-	88.9	82.3	80.8
Yearly income ($/100)				
<3,000	-	-	4.8	4.1
3,000-	-	-	6.5	5.5
7,000-	100.0	55.6	71.0	69.9
13,000-	-	33.6	16.1	17.8
Missing	-	11.1	1.6	2.7
n	(2)	(9)	(62)	(73)

children had the highest incomes; only 8 percent were under $3,000 while 18 percent were over $13,000.

Military Families and Control Children Living in States Where the WIC Criterion was Below 185 Percent of Federally Defined Poverty Level

Living on a Military Base. Seventy-three children, all of non-WIC mothers, lived on military bases at the time of enrollment in the study. Sixty-two of these children had never received WIC benefits, two children were currently in WIC, and nine had received WIC benefits in the past. These children came from more privileged families than the total control population (see Table IV-13). All but one of the mothers in military families were married, compared to 76 percent of the mothers in other control children's families. In addition, 29 percent of mothers in military families had more than 12 years of education, compared to 18 percent of mothers of other control children's families.

The weight, height, Quetelet's index, and head circumference of control children living on military bases were compared with those of other control children (see Table IV-14). In the full regression model (adjusted

Table IV-14

Mean Weight, Height/Length, Quetelet's Index, and Head Circumference: Military Control Children vs. All Other Controls

	Military controls	Other controls
Weight (kg)		
Age and sex adjusted	-0.527	13.014
Fully adjusted	-0.566	13.016
Height/length (cm)		
Age and sex adjusted	-1.213	88.182
Fully adjusted	-1.425*	88.316
Quetelet's index (kg × 100/cm)		
Age and sex adjusted	-.0041	0.167
Fully adjusted	-.0034	0.166
Head circumference (cm)		
Age and sex adjusted	0.054	47.987
Fully adjusted	-0.005	47.995
n	(62)	(683)

*p < 0.05.
**p < 0.01.
***p < 0.001.

for all social and demographic covariates), military children were somewhat lighter and shorter than other control children, but the differences were not significant. While the military group was better off socioeconomically, they appeared not to have accelerated anthropometric development. They were therefore retained in the analyses since they were not biasing the anthropometric results and to exclude them would have entailed massive reanalysis.

Controls from Areas Where WIC Income Eligibility was below 185 Percent of Federally Defined Poverty Levels. Income levels of families of control children of control women (such families were the only ones in the study that did not have to meet local WIC income criteria) were compared with all other families in areas using 185 percent of poverty income as the upper limit of WIC eligibility and in areas where the upper limit of eligibility was less than 185 percent of the poverty level (see Table IV-15). The WIC control disparity in income arose entirely from areas where the income eligibility criterion was 185 percent, not from areas where the criterion was below 185 percent. Therefore, controls from the latter areas were retained in the analysis, since they were not the source of WIC control bias.

4. Conclusions

It is evident that the families of current or former WIC recipients and of controls were sociodemographically dissimilar. The control group had better income, education, and employment status. Control children were more likely to be white, to have married parents with the father present in the household, to have parents with more education and higher incomes, and to be receiving AFDC or Medicaid. Families of children who were past recipients of WIC were more like those currently receiving WIC than those of control children, and contrasts between current and past WIC recipients are unlikely to be distorted by sociodemographic differences.

Thus, even with the statistical control, applied for all identified sociodemographic characteristics, real benefits of the WIC program may still have been masked by the higher status of the control group and observed benefits from the WIC program might well be underestimates. This is true because there is, inevitably, some error in the measurement of these variables; therefore, adjustment is to some extent incomplete. In addition, the operative sociodemographic and behavioral differences that both distinguish the study groups and influence outcome can never be defined completely.

On the other hand, the analytic scheme used with these data can help judge the likelihood of possible confounding of results by such group differences. If outcomes are unchanged or only slightly changed by the array of sociodemographic factors used in the statistical adjustment procedures, one can be moderately confident that the outcome is not particularly subject to the influence of socioeconomic factors and would be unlikely to be influenced if these factors were better specified in the analysis. Where adjusted differences differ from unadjusted differences interpretations must be made cautiously, but the greatest likelihood is that benefits from the WIC program would be underestimated in such situations.

Table IV-15

WIC Status and Family Income for Families of Study Children in PSUs by State WIC Income Eligibility Standards

States where upper limit of income for WIC eligibility is 185 percent of poverty level:

Family income ($/yr)	Non-WIC children of non-WIC mothers (%)	All other sample children (%)	Total (%)
<3,000	6.4	14.0	12.7
3,000-	23.2	36.6	34.4
7,000-	40.4	29.8	31.5
13,000-	19.2	12.8	13.8
Missing	10.8	6.9	7.5
Total	100	100	100
n	(250)	(1,290)	(1,540)

States where upper limit of income for WIC eligibility is less than 185 percent of poverty level:

Family income ($/yr)	Non-WIC children of non-WIC mothers (%)	All other sample children (%)	Total (%)
<3,000	15.2	12.1	12.3
3,000-	36.4	32.6	32.8
7,000-	33.3	32.2	32.2
13,000-	9.1	8.0	8.0
Missing	6.1	16.5	14.7
Total	100	100	100
n	(33)	(690)	(723)

*Columns add to 100 percent.

V. LONGITUDINAL STUDY OF PREGNANT WOMEN

INTRODUCTION

Low-income pregnant women constitute an important target group for the WIC program because of the potentially serious consequences of prenatal nutrition-related medical problems. A large body of scientific literature on prenatal nutrition supplementation indicates that such adverse outcomes may be avoided in needy women, including infant mortality, short gestational age, low birthweight, and neonatal morbidity. The goal of the Longitudinal Study of Pregnant Women is to determine if the current WIC program, in fact, reduces the rates of such outcomes among its pregnant participants.

1. Study Objectives

The objectives of the Longitudinal Study of Pregnant Women are to assess the effects of the WIC intervention on both the mother and the newborn child, and specifically to:

- Assess the effects of the WIC program on the dietary intake of women who participated prenatally.
- Determine changes in prenatal behavior and growth among WIC participants that may mediate newborn outcomes.
- Assess the effects of the WIC program on birth outcomes of pregnant WIC participants.

Maternal outcomes that were measured as part of this study include:

- Dietary intake including food consumption patterns and nutrient intake.
- Weight gain during pregnancy.
- Maternal energy storage and deposition.
- Utilization of prenatal care.
- Maternal health behavior, including smoking and alcohol use.

The newborn outcomes include:

- Gestational age at delivery.
- Birthweight.

- Birth length and head circumference.
- Morbidity/mortality.
- Breastfeeding behavior.

An additional objective is:

- To assess the interaction of WIC and/or components of WIC with characteristics of pregnant women to find which groups of women are more likely to benefit from WIC and which combinations of WIC components/characteristics are associated with optimal outcome.

2. Design and Analytic Issues

The purpose of the Longitudinal Study of Pregnant Women is to determine whether the WIC program has positive effects on the diet, use of medical services, health-related behavior, and birth outcomes of WIC recipients. The basic study design is a comparison of differential change in maternal characteristics and of the growth and well being of the offspring, among pregnant WIC participants and pregnant women who were presumably similar to the WIC women but who did not receive WIC benefits. Assessment and quantification of the three components of the WIC intervention (i.e., food supplementation, nutrition education, and coordination of health care) were completed for all WIC participants and controls.

The study design specified data to be collected twice prior to delivery. The baseline data were collected at entry into the WIC program or at the onset of prenatal care. The second contact was near the eighth month of pregnancy. Data gathered late in pregnancy allowed assessment of WIC program participation on maternal weight gain, change in skinfold thickness, change in dietary intake, and health care utilization during program participation. Effects of the WIC program on birthweight and other measures of infant growth and duration of gestation are judged from data abstracted from hospital delivery records.

The general method used to test the effects of the WIC program was linear multiple regression analysis, in which variables describing characteristics on which the study groups might differ and that might also affect study outcome were statistically adjusted. This method of statistically controlling or adjusting for variables on which the study groups may differ is discussed below.

Multiple regression analysis relates a dependent variable to a set of independent variables. The dependent variables in this evaluation are the health behaviors and outcomes that are likely to be affected by enrollment in the WIC program. They include women's diet, physical measures, health practices, duration of gestation, infant anthropometry, and vital status.

A regression coefficient is generated for each independent variable in the regression analysis. These coefficients indicate the relationship of

change in the outcome variable with change in one unit of the independent variable, controlling for the effects of all other independent variables in the regression equation. Most of the outcome variables in the evaluation are continuous variables, and for them, regression coefficients for the independent variables can be interpreted in terms of the units in which the outcome is measured. A few of the study outcomes are dichotomous, coded 1 if the outcome is present and 0 if not. In the case of multiple regression with dichotomous outcomes, the regression coefficients are interpreted as proportions or, after multiplication by 100, as centiles.

The independent variables consist of four subsets. The first set is composed of binary (0-1) variables that indicate whether or not WIC benefit was received.

The second set of independent variables is composed of covariates. These are variables measuring background characteristics (e.g., ethnicity, income, and education) and medical indicators of risk (e.g., previous low birthweight and maternal smoking) of the women in the sample. The inclusion of the covariates in the analyses aims to adjust statistically for any noncomparability between the WIC and control groups. Any analysis of the effects of WIC benefits will therefore be controlled for measured differences in the covariates across study groups.

The third set of independent variables is composed of interaction variables. These variables are used to measure the differential effect of WIC within subsamples, defined by several different risk criteria.

The fourth set is composed of variables that may mediate WIC's effect on a particular outcome. In all analyses of measures that have parallel measures at the initial and followup interviews, group differences in the initial measure were estimated to judge initial comparability across study groups. In addition, the initial measure was included in the regression model estimating group difference at followup interview.

B. DIETARY INTAKE

1. Introduction

WIC food packages are designed to supplement the intake of key nutrients in the diets of low-income pregnant and lactating women and in the diets of infants and children at nutritional risk. Public Law (PL) 94-105 (November 7, 1975), which authorized the WIC program, specified these nutrients to include high-quality protein, iron, calcium, Vitamin C, and Vitamin A. However, this legislation was superceded by PL 95-627 (November 10, 1978), which states more generally that supplemental foods should contain "nutrients determined by nutritional researchers to be lacking in the diets" of the targeted population.

To assess WIC's effectiveness in supplementing dietary nutrients, 24-Hour Dietary Recalls at initial interview were collected on a random sample of 75 percent of women who agreed to participate in The National WIC

Evaluation (n = 4,810). At reevaluation later in pregnancy, 3,691 (77 percent) of these women were available for a second dietary interview: 2,927 in the WIC group (76.8 percent of those with initial recalls) and 764 among initial controls (76.6 percent of those with initial recalls). Two hundred and five of the controls at followup had been enrolled in the WIC program between study recruitment and followup visit ("WIC/controls"). It was required that the initial recall describe a 24-hour period before the WIC program could have affected the woman's diet. It was stressed to field staff that the dietary recall at initial interview had to reflect the 24-hour period before WIC benefits began and before nutrition education might have affected dietary patterns. Followup interviews were scheduled between the 31st and 37th weeks of gestation, for both WIC women and controls.

Nutrient Database

The nutrient database used to analyze these and other nutrients was the USDA Nutrient Data Base for Individual Food Intake Surveys (Release 1, 1980). This database provides information for 15 nutrients--calories, protein, fat, carbohydrate, calcium, iron, magnesium, phosphorus, Vitamin A, thiamin, riboflavin, niacin, Vitamin B_6, Vitamin B_{12}, and Vitamin C.

Cereals are a major component of the package of foods supplied to WIC recipients. Therefore, the database was supplemented from the Revised Agriculture Handbook 8-8 (Breakfast Cereals) to provide the best estimate of the nutrient content of cereals. Extensive information from food manufacturers and other nutrient databases also was solicited and used to supplement the USDA nutrient database (see Volume IV, Appendix V-A).

Definition of WIC Foods

Foods potentially available from WIC were specified in The National WIC Evaluation nutrient database to assess consumption of foods provided in the WIC package. Definitions of WIC foods were obtained from the official program regulations (Federal Register, November 12, 1980) and from supplemental lists of cereals provided by national WIC program staff (see Appendix V-A). Foods designated as WIC foods are listed in Appendix V-A.

While WIC regulations specify different food packages for women and for infants and children of different ages (e.g., 0 to 3 months, 4 to 12 months, and 1 to 5 years), a common list of WIC foods was prepared for the separate analyses of women, infants, and children. Thus, it would be possible that infant formula consumed by a woman would be included as a WIC food, although not available as a WIC benefit. However, it is unlikely that baby foods and infant formula are eaten frequently enough by women to distort these results or, conversely, that young infants (0 to 4 months) usually do not consume the foods supplied by the WIC program to women and older children.

Cereals meet WIC program requirements only if they contain at least 45 percent of the U.S. Recommended Daily Allowance (RDA) for iron and 6 g or less of sucrose or other sugars per ounce of dry cereal. Dried beans and peas, peanut butter, milk, cheese, and eggs also are included as WIC foods as specified in the WIC regulations. Only juices that contain a minimum of 30 mg/100 ml of Vitamin C are included in WIC food packages. Juice drinks are not allowed. Orange and grapefruit juices do not require fortification to meet this requirement, nor does combined orange-grapefruit juice. Apple juice, grape juice, and pineapple juice do require fortification. State WIC programs generally specify allowed brands of fortified juices to WIC recipients and vendors. Brand names and fortification information of all potentially WIC-eligible food items were not available for this evaluation effort. Therefore, juices requiring fortification were not defined in these analyses as foods available from the WIC program.

Home-prepared dishes that included WIC-eligible foods as minor components were not considered WIC foods. As an example, while many forms of cheese are WIC foods, macaroni and cheese was excluded. If a WIC food was judged to be a predominant component in the home-prepared dish, it was included in the analysis as a WIC food. Thus, refried beans and scrambled eggs were included.

2. Analytic Methods

Women were included in the dietary analyses only if they received dietary recalls at both initial and followup interviews. The initial 24-Hour Dietary Recall referred to a day that preceded contact with the WIC program or clinic. If the study woman was a WIC participant, the reported period preceded WIC program enrollment. If the woman was in the control study group, the 24-hour recall period was prior to the day of enrollment for prenatal services. Thus, the baseline measures should have been unaffected by the delivery of WIC program benefits or prenatal care.

Among those receiving initial and followup interviews, women were excluded from the analyses if they were diagnosed as diabetic (n = 133), if they reported being prescribed a diabetic diet (n = 15), if their dietary recall was only partially completed (n = 2), or if the recall included amounts of a macronutrient that were implausibly high. Five hundred and twenty-five recalls with suspect nutrient intakes (251 at initial interview and 274 at followup) were reviewed for recording and other errors. Thirteen recalls were finally rejected because of suspicious entries that could not be resolved.

WIC status for these analyses is defined as WIC (women who were being enrolled in WIC at initial interview and who were drawn from a nationally representative sample of WIC recipients), WIC/control (women enrolled as controls at initial interview but who were subsequently enrolled in the WIC program prior to the followup interview), and control women (those enrolled as controls at initial interview and not subsequently enrolled in WIC). For reporting purposes, dietary results are presented contrasting both the WIC and WIC/control groups with control women.

Mean Nutrient Intake at Recruitment

The following analyses were conducted for each of the 15 nutrients available in the nutrient database:

- The mean nutrient intake at recruitment into the study was calculated, adjusted only for duration of gestation at registration into the study.

- The mean nutrient intake at recruitment into the study was calculated, adjusted for duration of gestation at registration and also for 35 maternal characteristics that might have affected nutrient intake and might have distorted study results if present at unequal rates across study groups. Characteristics included maternal ethnicity; age; parity; delivery of low-birthweight infants or stillbirths; cigarette smoking; marital status; receipt of Medicaid, Aid to Families with Dependent Children (AFDC) (welfare) and Food Stamps; number of hours of work and level of exertion of work; availability of kitchen facilities in the home; family income and household size; parental education, occupation, and employment status; and whether the index day's dietary intake was considered usual. (These covariates are specified in Volume IV, Appendix V-A.)

These first two analyses serve two functions. First, they permit a measure of comparability of initial dietary intakes across groups. If disparity exists across groups, subsequent intake after program enrollment may be argued to be influenced by the noncomparable initial intake, even with analytic control for initial intake. Second, the control group, in general, was more privileged than those enrolled in the WIC program. Thus, when adjustments are made for this large array of characteristics, true differences may emerge or spurious and confounded differences that were functions of maternal characteristics might be eliminated.

If adjustment procedures change estimates of differences across the study group minimally, observed differences are more likely to be real and not due to confounding. Thus, although groups are different for several social or demographic characteristics, these differences are not operative on the outcomes under study. Unless otherwise stated, the reported results for initial intake referred to in the text are those adjusted for the larger set of covariates.

Mean Nutrient Intake at Followup

The following analyses were conducted for each of the 15 nutrients:

- The intake at followup in late pregnancy was calculated, adjusted only for the duration of gestation at registration into the study, the duration of gestation at followup, and the reported intake of that nutrient at registration. These group differences

in reported nutrient intake at followup are for change in nutrient intake, since intake is adjusted for initial intake.

- The intake at followup was calculated, adjusted for duration at registration and at initial and followup visits, the initial reported nutrient intake, and the same set of maternal covariates as above. These covariates relate only to maternal characteristics known at registration into the study and contain no information on change after registration. Thus, the results of this analysis are the estimates of the effect of the WIC program and, unless otherwise stated, the contrasts that are adjusted for these characteristics known at recruitment into the study are the results for dietary intake at followup referred to in the text.

- Finally, the intake at followup in late pregnancy was calculated, adjusted not only for maternal characteristics at registration in the study, but also change between recruitment into the study and followup that might have mediated some of the effects of the WIC program. (See Volume IV, Appendix V-A3 for complete specification.) Information is included on how many times the woman received dietary counseling, from whom, and whether she considered it to be effective; on change in whether she was working, hours worked, hours on feet at work, and level of exertion at work; whether the womans' diet at followup was unusual; whether she reported pica, the number of prenatal visits between recruitment and followup, and change in cigarette smoking. The rationale for this analysis is that the effects of the WIC program are possibly mediated by factors in addition to the simple provision of food supplements. For example, counseling may have led to other advantageous health behaviors, such as decreased smoking or improved eating patterns. It is conceivable that part of the WIC benefit may have been to allow women to reduce the time spent at work, particularly heavy work. The difference between the estimated WIC program effect in analysis compared to this analysis is an estimate of the WIC effect associated with activities other than distribution of food.

Scope of Analyses

The above five analyses were carried out for:

- Mean intakes of each of the 15 nutrients.

- The proportion of women in each study group reporting low intake for each of 11 nutrients.

- The mean nutrient intake adjusted for the concurrent caloric intake.

- The nutrient intake from foods that are supplied directly by the WIC program.

The proportion of women in each study group reporting low intake was established by using 100 percent of the Recommended Energy Intake and 77 percent of the RDA for all other nutrients (National Research Council, 1980). It is estimated that at 77 percent of the RDA, 50 percent of the population has an adequate intake. The RDAs for pregnancy were chosen from the levels for women between 19 and 22 years of age, as did Edozien et al. (1976a, 1976b, 1979). (There is little difference between these RDAs and those for women below 19 or over 22.) Deficiency of fat and carbohydrate intake was not studied since there are no RDAs, and an analysis of the RDA for iron intake in pregnancy was omitted since there is no RDA, but rather a recommendation that all pregnant women receive 30 to 60 mg of elemental iron daily. Such high intake requires iron supplements and is outside that routinely available from dietary sources.

The mean nutrient intake adjusted for the concurrent caloric intake is equivalent to nutrient density. This analysis permits an assessment of whether an incremental intake of each nutrient was over and above differences in caloric intake (i.e., whether the diets were more nutrient dense).

The assessment of nutrient intake from WIC foods helps to estimate whether any changes in diet caused by enrollment in the WIC program were mediated by foods available from the WIC food package. If changes in nutrient intake were from WIC foods then the receipt of WIC food packages was certainly important (although it would still be uncertain whether nutrition education had a major influence). If increased nutrient intake associated with the WIC program was not mediated specifically by WIC foods but was contributed by all foods in the diet, the nutrition education component of WIC was probably more important than the provision of food.

Presented in Volume IV, Appendix V-A are the means, standard deviations, and variable definitions for all variables included in the linear multiple regression models used for dietary analyses. In Appendices V-B-1 and V-B-2, the complete set of regression analyses for two nutrients, calories and iron, are displayed to give the reader an example of the way our analytic strategies have been applied.

3. Results

Analyses are presented based on paired recalls for 3,473 women: 2,762 in the WIC group, 181 who initially were controls but who subsequently enrolled in the WIC program, and 530 residual controls.

Initial mean nutrient intakes were not significantly different across the three study groups, either in the partially or fully adjusted analyses. Adjustment for the full array of maternal characteristics changed estimated differences in initial caloric intake between the WIC and control groups by less than 10 calories. Thus, all three study groups were following diets that were indistinguishable in nutrient content at entry into the study, and adjusting for a large array of maternal sociodemographic and health characteristics had little or no effect on these estimates. These observations increase the credibility of study results since nutrient intake was

similar at the onset of the study, and sociodemographic differences that did exist across study groups did not influence estimated nutrient intake.

As a measure of the reliability of the 24-hour Dietary Recalls at initial and followup interviews, the variance ratios for each nutrient were calculated from correlation coefficients partialled for income at initial interview, ethnicity, WIC status (WIC, WIC/control, control), and duration of gestation at both interviews.* Variance ratios were considerably higher than those found in other studies. Rush and Kristal (1982) and Beaton et al. (1979) found variance ratios of 1.14 and 1.40 for energy, while it was 2.54 in this study. A reason for the greater unreliability in this study may have been the relative inexperience of the field operatives. On the other hand, such unreliability is likely to make all estimates of association of dietary change due to the WIC program more difficult to detect and alone cannot cause program effects to be overestimated.

There were three significant differences in the nutrient densities at initial interview between the relatively few WIC/controls (n = 180) and controls (see Volume IV, Appendix V-B-3). Control women who later enrolled in the WIC program had initial diets more dense in carbohydrates and less dense in fat and phosphorus. These results are likely to be chance findings.

More important are the significantly greater intakes at study recruitment from WIC foods by the initial WIC sample for most nutrients. The absolute magnitudes are small, but the relationships are consistent. While only 49 of 2,756 (1.8 percent) women in the WIC sample had initial dietary recalls that referred to a day when they were already enrolled in the WIC program, intake might have been affected by the presence of children in the household who were WIC recipients.

In any case, these reportedly greater nutrient intakes from WIC foods at study onset would minimize estimated effects of the WIC program on intake of WIC foods at followup, since followup intake was adjusted for the initial intake of WIC foods. Thus, estimated effects of the WIC program on nutrient increases from WIC foods would tend to be low if some women had initial dietary recalls affected by prior contact of other family members with the WIC program. This effect should have led only to low, and not high, estimates of effects of the WIC program on intakes of WIC foods.

In the fully adjusted analyses, there were no significant differences between initial WIC recruits and controls in the proportion of women at initial interview with low nutrient intake. In the analysis adjusted only for duration of gestation at interview, WIC/control women had a significantly greater frequency of low niacin intake than controls.

---

*Variance ratio = $\frac{1-r}{r}$. The higher the variance ratio, the lower the reliability. With a variance ratio of two, a true correlation of one between diet and some other factor would be attenuated to 0.58.

WIC Program Participation

Provided below are descriptions of dietary intake at followup for the 15 nutrients analyzed for WIC participants, WIC/control women, and controls. The results are summarized in Tables V-1 through V-4. The adjusted mean intake of controls is presented in the right column of the tables for each analysis and the (adjusted) group differences in the two left columns.

Energy. Increases in caloric intake in both WIC groups at the time of reevaluation were significant, both in the partially and fully adjusted analyses (see Table V-1). The WIC group reported consuming 111 calories more than controls ($p < 0.01$) and the WIC/control group reported consuming 142 calories more than controls ($p < 0.05$). Approximately 29 percent of the increment in the WIC group and 23 percent of the increment in the WIC/controls group was associated with the set of possible mediating variables (not displayed). This suggests effects of the WIC program of moderate magnitude over and above the provision of food. The differences in overall intake associated with WIC benefits (111 and 142 calories) are entirely accounted for by the differences in caloric intake from WIC foods (128 and 152 calories).*

A little less than half the incremental calories from WIC foods were supplied by dairy foods (70 and 72 calories in the WIC and WIC/control groups) smaller but about equal amounts from juices and cereals (26 and 29 calories, respectively, in the WIC group and 29 and 35 calories in the WIC/control group) and still smaller amounts from other potential WIC foods (18 and 20 calories among WIC and WIC/control groups) (see Table V-4).

While the increments in caloric intake of 5.8 percent to 7.5 percent (111 and 142 calories) from WIC program participation may not appear to be very great, they are similar to reported increments in studies among deprived women. For instance, Mora et al. (1979) supplied over 800 calories per day in their supplementation trial of poor pregnant women in Bogotá, but women reported increasing intake by only 133 calories per day. The INCAP studies in Guatemala posited effects on fetal growth from consumption of 20,000 incremental calories over the course of pregnancy, an average of about 75 calories a day (Habicht et al., 1974). Rush et al. (1980a, 1980b) observed increments of over 200 calories a day from supplementation in a randomized trial in New York, but such increments were exceptional.

The residual group of controls at followup was more likely to have low caloric intake than at the initial visit (79 percent vs. 74 percent) (see Table V-2). Both groups of WIC recipients were significantly less likely

*Data reported for nutrient intakes from WIC foods in Tables V-1 and V-4 vary due to slight differences between the two analyses. These differences do not affect statistical significance between groups in any way.

Table V-1

Significant Differences[a] in Mean Dietary Intake[b] of Energy and Selected Nutrients

Nutrient	Total intake			Intake from WIC foods		
		Controls at registration			Controls at registration	
	WIC at registration	WIC at followup	Controls at followup	WIC at registration	WIC at followup	Controls at followup
Energy (kcal)						
Initial	-14.44	49.26	2,001.46	46.70**	-13.06	381.95
Followup	110.75**	142.07*	1,905.34	128.32***	151.90***	352.55
Protein (g)						
Initial	-1.14	-1.61	80.79	2.26*	-1.31	20.59
Followup	5.22**	6.48	75.54	5.48***	6.26***	18.97
Fat (g)						
Initial	-1.20	-1.44	85.53	1.86*	-1.26	19.51
Followup	4.68*	4.90	78.51	4.38***	5.54***	17.91
Carbohydrate (g)						
Initial	.82	17.27	231.00	5.57**	1.16	31.69
Followup	12.54*	17.81	228.26	17.68***	19.95***	29.44
Calcium (mg)						
Initial	43.35	3.06	917.68	59.34*	-43.48	535.93
Followup	132.67***	172.51***	870.99	138.80***	151.08***	504.38
Iron (mg)						
Initial	-.11	-.11	14.53	.67*	.04	2.20
Followup	3.16***	4.47***	14.06	3.85***	5.05***	1.93
Magnesium (mg)						
Initial	6.61	5.46	254.30	12.75***	1.34	73.79
Followup	25.46***	20.78	243.80	27.49***	30.46***	71.55
Phosphorus (mg)						
Initial	2.79	-17.96	1,342.49	54.27*	-36.97	519.11
Followup	133.03***	168.79**	1,249.75	138.56***	158.38***	479.73
Vitamin A (IU)						
Initial	398.12	-258.51	5,770.85	214.41*	14.29	1,028.51
Followup	777.73	1,023.49	6,109.25	1,069.53***	1,407.01***	950.87

See footnotes at end of table.

(continued)

Table V-1 (continued)

Nutrient	Total intake			Intake from WIC foods		
		Controls at registration			Controls at registration	
	WIC at registration	WIC at followup	Controls at followup	WIC at registration	WIC at followup	Controls at followup
Thiamin (mg)						
Initial	.04	.08	1.47	.07**	.02	.28
Followup	.34***	.46***	1.42	.35***	.45***	.27
Riboflavin (mg)						
Initial	.08	.04	1.97	.12**	-.02	.74
Followup	.37***	.55***	1.97	.44***	.57***	.71
Niacin (mg)						
Initial	-.46	.49	19.68	.83**	.40	1.27
Followup	3.23***	4.70***	18.69	3.76***	5.15***	1.34
Vitamin B_6 (mg)						
Initial	-.05	.05	1.65	.08*	.02	.29
Followup	.34***	.35**	1.57	.41***	.53***	.28
Vitamin B_{12} (mcg)						
Initial	-.23	-1.40	5.70	.32**	-.02	1.86
Followup	1.27*	2.29*	5.36	1.35***	1.79***	1.77
Vitamin C (mg)						
Initial	5.24	9.33	120.37	9.19*	9.99	39.04
Followup	32.43***	29.84**	111.68	35.72***	42.32***	34.21
Total (n)	2,762	181	530	2,762	181	530

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Control group means and differences from means for WIC groups. Significance refers to the difference from control group means.

[b]Total intake and intake from potential WIC foods at (i) initial interview, controlled for duration of gestation at registration into study (see Volume IV, Appendix V-A-3, for full covariate list), and at (ii) followup interview, controlled for initial intake, duration of gestation at both interviews and maternal characteristics into the study.

Table V-2

Proportion of Women with Dietary Intakes Below the 100th Percentile of the Recommended Energy Intake and Below the 77th Percentile of Recommended Daily Allowances (RDAs)[a] for Selected Nutrients[b]

Nutrient	Proportion with intake under the 77th percentile of the RDA (%)[c]		
	WIC status		
		Controls at registration	
	WIC at registration	WIC at followup	Controls at followup
Energy (kcal)			
Initial[d]	.33	-4.22	73.75
Followup[e]	-5.60**	-8.16*	78.81
Protein (g)			
Initial	-.25	.20	30.68
Followup	-2.38	-6.84	31.79
Calcium (mg)			
Initial	-1.87	4.45	58.23
Followup	-8.08***	-12.14**	59.84
Magnesium (mg)			
Initial	-4.23*	-6.59	83.50
Followup	-6.90***	-6.46*	84.17
Phosphorus (mg)			
Initial	.73	-.92	29.56
Followup	-5.86**	-11.73**	32.21
Vitamin A (IU)			
Initial	-.51	-.38	54.39
Followup	-3.87	-7.68	50.15
Thiamin (mg)			
Initial	-.49	.40	45.53
Followup	-6.80**	-10.97**	45.16
Riboflavin (mg)			
Initial	1.45	3.56	26.90
Followup	-5.40**	-9.98**	27.96

(continued)

Table V-2 (continued)

Nutrient	Proportion with intake under the 77th percentile of the RDA (%)[c]		
	WIC status		
		Controls at registration	
	WIC at registration	WIC at followup	Controls at followup
Niacin (mg)			
Initial	3.71	7.72	27.77
Followup	.28	.88	27.88
Vitamin B_6 (mg)			
Initial	4.06	5.05	70.76
Followup	-3.87	-2.50	72.46
Vitamin B_{12} (mcg)			
Initial	.62	3.41	34.48
Followup	-6.44**	-9.92*	39.87
Vitamin C (mg)			
Initial	-1.61	-.70	40.82
Followup	-8.90***	-9.52*	41.44
Total (n)	2,762	180	530

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a] For pregnant women age 19-22 (National Research Council Food and Nutrition Board, 1980).

[b] Control group means and differences for WIC groups. Significance refers to difference from control group means.

[c] Percent less than the 100th percentile of the Recommended Energy Intake for energy.

[d] Initial interview controlled for gestation at registration and maternal characteristics at registration into study. (See Volume IV, Appendix V-A-3, for full covariate list.)

[e] Followup interview controlled for initial intake, duration of gestation at both interviews, and maternal characteristics at registration into the study.

Table V-3

Mean Nutrient Intake as Percentage of the Recommended Daily Allowance[a]

		WIC status			Followup intake (% RDA)		
			Controls @ registration			Controls @ registration	
Nutrient	RDA	WIC @ registration	WIC @ followup	Controls @ followup	WIC @ registration	WIC @ followup	Controls @ followup
Energy	2400 kcal	83	85	84	84	85	79
Protein	74 g	108	107	109	109	111	102
Calcium	1200 mg	80	77	76	84	87	73
Magnesium	450 mg	58	58	57	60	59	54
Phosphorus	1200 mg	112	110	112	115	118	104
Vitamin A	5000 IU	123	110	115	138	143	122
Thiamin	1.5 mg	101	103	98	117	125	95
Riboflavin	1.6 mg	128	126	123	147	158	123
Niacin	16 mg	120	126	123	137	146	117
Vitamin B_6	2.6 mg	62	65	63	73	74	60
Vitamin B_{12}	4.0 mcg	137	108	143	166	192	134
Vitamin C	80 mg	157	162	150	180	177	140
n		2,762	181	530	2,762	181	530

[a]Food and Nutrition Board, National Academy of Sciences - National Research Council, 1980, RDA for pregnant women aged 19 to 22 years of age. (Nutrient intakes adjusted for all maternal characteristics; intake at followup also adjusted for initial intake.)

to have low caloric intake at revisit than controls: 5.6 percent fewer among the initial WIC sample ($p < 0.01$) and 8.2 percent fewer among those who had been controls but who later enrolled in the WIC program ($p < 0.05$). Twenty-six percent of the increment between the initial WIC group and controls and 16 percent among WIC/controls and controls were mediated by factors other than the provision of food, again implying moderate effects over and above the availability of the WIC food package.

The mean intakes of the entire population of pregnant women were far lower than Recommended Energy Intakes. At followup, mean intakes of the WIC, WIC/control, and control groups were 84 percent, 85 percent, and 79 percent of the Recommended Energy Intake, respectively (see Table V-3; also Volume IV, Appendix V-B-4). These recommended levels are consistent with most empirical research on diet intake, either during pregnancy or among women of childbearing age, in this country. For example, pregnant and lactating women ($n = 471$, mostly pregnant) in the Ten State Survey consumed 1,973 kcal, or 82 percent of the RDA per day.

Protein. The mean total protein intake among controls fell from 81 g/day at recruitment to 76 g/day at followup, although the frequency of intake below 77 percent of the RDA remained nearly constant across time (30.7 percent and 31.8 percent). At followup, both WIC groups were consuming more protein than controls were consuming (5.2 g, $p < 0.01$ among the WIC group, and 6.5 g, not significant [n.s.] among WIC/controls). These protein increases supplied 18.7 and 18.3 percent of the caloric increments associated with WIC participation. These protein densities, neither low nor high, are in the range of generally nutritious diets. The differences in protein intake between the WIC and control groups were supplied by WIC foods; the estimated differences in protein intake from WIC foods were nearly identical to estimates of differences in total intake. About two-thirds of the incremental intake in protein from WIC foods was from dairy products (see Table V-4; also, Appendix V-B-5).

Finally, reductions in the frequency of low protein intake were associated with WIC benefits (see Table V-2), but they were not significant.

Fat and Carbohydrate. The difference in caloric intake in the WIC groups at followup, compared to controls, was contributed more by carbohydrate (12.5 g [$p < 0.05$] and 17.8 g [n.s.], or 50 kcal and 71 kcal, in the initial WIC and WIC/control groups, respectively) than by fat ([4.7 g [$p < 0.05$] and 4.9 g [n.s.], or 42 and 44 kcal, in the WIC and WIC/control groups, respectively). Table V-1 summarizes these findings. The increments in fat for the total diet were nearly identical to the estimates of increments from WIC foods, which is parallel to the findings in protein intake.

Calcium. Initial WIC recruits reported consuming 43 mg more calcium at registration than controls (n.s.) and 59 mg more from WIC foods ($p < 0.05$, see Appendix V-B-3). (Because all analyses of intake after enrollment in the WIC program are adjusted for initial levels, the higher levels

Table V-4

Mean Dietary Intake[a] from Component Food Groups of WIC Food Packages[b] at Followup Visits[c,d]

	Food group											
	WIC dairy foods			WIC juices			WIC cereals			Other WIC foods		
		Control at registration			Control at registration			Control at registration			Control at registration	
Nutrient	WIC at registration	WIC at followup	Controls at followup	WIC at registration	WIC at followup	Controls at followup	WIC at registration	WIC at followup	Controls at followup	WIC at registration	WIC at followup	Controls at followup
Energy (kcal)	69.73**	71.95**	231.66	26.27**	29.08**	29.54	28.82**	34.69**	4.95	18.62*	19.51	81.29
Protein (g)	3.94**	3.79**	13.12	.40**	.44**	.46	.70**	.96**	.13	1.05*	1.15	5.07
Fat (g)	4.14**	4.32**	12.87	.06**	.07**	.07	.14**	.15**	.03	.93	1.13	4.65
Carbohydrate (g)	4.32**	4.62**	16.39	6.25**	6.92**	7.02	5.89**	7.60**	1.08	1.74	1.33	4.71
Calcium (mg)	134.81**	131.69**	460.58	5.20**	5.75**	5.91	7.00**	9.44**	1.69	4.65	5.49	31.41
Iron (mg)	.11**	.11**	.36	.07**	.08**	.07	3.46**	4.86**	.52	.22*	.22	1.00
Magnesium (mg)	12.85**	13.37**	46.54	5.84**	6.46**	6.57	5.05**	7.03**	.96	5.87*	4.78	16.69
Phosphorus (mg)	110.39*	105.20**	375.47	9.20**	10.18**	10.50	17.57**	24.67**	3.30	17.78*	18.74	84.76
Vitamin A (IU)	159.75**	126.90*	560.11	109.12**	121.02**	130.49	815.46**	1,208.50**	95.57	10.12	20.41	154.65
Thiamin (mg)	.04**	.04**	.13	.05**	.05**	.06	.25**	.37**	.03	.01*	.01	.04
Riboflavin (mg)	.16**	.17**	.57	.01**	.01**	.01	.28**	.41**	.03	.01	.02	.09
Niacin (mg)	.09**	.10**	.35	.17**	.19**	.20	3.35**	4.90**	.42	.25	.25	.36
Vitamin B_6 (mg)	.04**	.04**	.14	.02**	.02**	.02	.33**	.49**	.04	.02*	.01	.08
Vitamin B_{12} (mcg)	.36**	.37**	1.30	-	-	0	1.00**	1.45**	.12	.03	.05	.34
Vitamin C (mg)	.90**	.99**	3.43	25.51**	28.25**	29.48	9.55**	14.09**	1.04	-.08	-.11	.13

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Mean daily intake of calories, protein, fat, carbohydrates, calcium, iron, magnesium, phosphorus, Vitamin A, thiamin, riboflavin, niacin, Vitamin B_6, Vitamin B_{12}, and Vitamin C.

[b]Dairy foods, juices, cereals, and other foods.

[c]Control group means and differences from means for WIC groups. Significance refers to differences from control group means.

[d]Controlled for initial intake, duration of gestation at both interviews and maternal characteristics at registration into the study. (See Volume IV, Appendix V-A-3, for full covariate list.)

at recruitment do not lead to overestimates of program effects at followup.) The WIC group reported eating 133 mg more per day than controls at followup ($p < 0.001$), and WIC/control women reported eating 173 mg more ($p < 0.001$). After control for caloric intake, the differences were still substantial (94 and 108 mg) and highly significant. Thus, while part of the difference was due to an increase in overall dietary intake, most was due to a change in nutrient density. The reported differences in intake were due entirely to foods available in the WIC package (139 and 151 mg). Almost all of this incremental intake was from dairy foods (see Table V-4).

Some 58 percent of control women had low calcium intake at registration, and 60 percent had low calcium intake at later assessment (see Table V-2). There were no significant differences in the frequency of low intake between the WIC groups and control women at registration, but there was a significant decrease in the rate of low intake after study enrollment (8.1 percent less in the initial WIC sample [$p < 0.001$]; 12.1 percent less among those who had been controls [$p < 0.01$]). In the WIC group about 26 percent and in the WIC/control group 16 percent of the increase can be attributed to mediating factors associated with WIC over and above the food package (see Volume IV, Appendix V-B-3). The greatest part of the benefit was thus associated with the provision of food.

<u>Magnesium and Phosphorus</u>. WIC participation was associated with 25 mg greater magnesium intake in the WIC group ($p < 0.001$) and 21 mg among WIC/control women (n.s.), and 133 mg greater phosphorus intake ($p < 0.001$) in the WIC group, and 169 mg among WIC/control women ($p < 0.01$) (see Table V-1). These differences were contributed by WIC foods. The richest sources of both nutrients were WIC dairy foods (see Table V-4), but substantial contributions came from juices, cereals, and other WIC foods.

Eighty-four percent of control women reported low magnesium intake at both study onset and followup, and at both visits fewer women in the WIC group had low intake (4.2 percent fewer at initial intake [$p < 0.05$] and 6.9 percent fewer at followup [$p < 0.001$]). Among WIC/control women, 6.6 percent fewer had low intake at initial interview (n.s.) and 6.5 percent fewer had low intakes at followup ($p < 0.05$) compared to control women. Thirty percent of control women at initial interview and 32 percent at followup had low phosphorus intakes; both WIC groups had nearly identical rates to those of controls at initial interview but substantially lower rates at followup (about 6 percent fewer in the WIC group [$p < 0.01$] and 12 percent fewer among WIC/controls [$p < 0.01$]).

<u>Iron</u>. There were no differences in mean iron intake at initial visit across study groups. Highly significant increments were associated with WIC, both in the WIC group (3.2 mg; $p < 0.001$) and among WIC/controls (4.5 mg; $p < 0.001$). The bulk of the effect of participation in the WIC program was on nutrient density and was thus over and above changes in caloric intake (see Appendix V-B-3). Mediating factors other than food supplements accounted for only 10 percent of the difference in the WIC and WIC/control groups. The increase in mean iron intake was entirely account-

ed for by reported differences in intake from foods available in WIC food packages. At followup, control women were getting a very small amount of iron from potential WIC foods (2 mg), while the WIC and WIC/control groups consumed about 6.8 and 8.2 mg, respectively. Most of the increase in iron from WIC foods was supplied by cereals (3.5 mg greater than controls among the WIC group and 4.9 mg greater than controls among WIC/controls from WIC cereals). The other three categories of WIC foods in total supplied less than half a milligram of incremental iron.

The frequency of low intake of iron was not calculated since no RDA has been established for pregnancy.

Vitamin A. There were no significant differences in mean Vitamin A intake or in the frequency of low Vitamin A intake associated with the WIC program. There were significant increases in mean intake from WIC foods of 1,084 and 1,456 international units (IU) in the WIC and WIC/control groups, respectively, compared to the controls ($p < 0.001$).

Thiamin. Neither the mean intake nor the proportion of women with low intake was different across study groups at registration. There were highly significant increases in mean intake in both WIC groups at followup (0.34 mg and 0.46 mg, both $p < 0.001$). Most of this change was in nutrient density, rather than associated with increased total caloric intake (see Volume IV, Appendix V-B-3). After control for differences in caloric intake, these differences in nutrient density were 0.26 and 0.36 mg (both $p < 0.001$). The reported differences of 0.35 and 0.45 mg (both $p < 0.001$) in intake from WIC foods were almost identical to the increments in the total diet. By far, the largest component of the difference in intake between the WIC groups and controls was contributed by WIC cereals. While differences from dairy products, juices, and other WIC foods were statistically significant, they were of low magnitude.

Forty-five percent of control women had low thiamin intakes at followup, with about 7 percent fewer in the WIC sample ($p < 0.01$) and 11 percent fewer among WIC women who had been controls ($p < 0.01$).

Riboflavin. There were no significant differences across study groups in either mean intake or in the likelihood of low intake of riboflavin at registration. Highly significant increments in mean intake of riboflavin were associated with WIC enrollment at followup (0.37 mg in the WIC group [$p < 0.001$] and 0.55 mg among WIC/controls [$p < 0.001$]). At followup, 28 percent of control women had low riboflavin intake; 5.4 percent fewer women in the WIC sample ($p < 0.01$) and 10 percent fewer in the WIC/control group ($p < 0.01$) had low intakes. The increment in riboflavin was mostly from increased nutrient density (see Appendix V-B-3). The entire difference in mean total intake was contributed by differences in intake of food available from the WIC package. About two-thirds of the increment was from cereals, and one-third was from dairy products.

Niacin. Total mean intake of niacin at study recruitment was unrelated to whether or not a woman received subsequent WIC benefits. However, frequency of low intake was higher, although not significantly, in both WIC groups (31.5 percent in the WIC group and 35.5 percent among WIC/controls vs. 27.8 percent among controls). At followup, both WIC groups were eating significantly more niacin (3.2 mg more in the WIC group [$p < 0.001$], and 4.7 mg more among WIC/controls [$p < 0.001$]). These differences were supplied by WIC foods, predominantly WIC cereals (see Table V-4).

The rate of low intake at followup among controls was 27.9 percent. Rates of low intake among both WIC groups were essentially identical with that of controls.

Vitamin B_6. The total mean intake at registration was not significantly different across study groups. Both WIC groups were 4 to 5 percent more likely to have low intakes than controls at registration, but these differences were not significant. At followup, highly significant increments in Vitamin B_6 intake were associated with the WIC program (WIC group, 0.34 mg more than controls [$p < 0.001$]; WIC/controls, 0.35 mg more than controls [$p < 0.01$]). While women in both WIC groups more often had low intake at registration, the WIC group was 3.9 percent less likely and WIC/controls were 2.5 percent less likely than residual controls to have low intake at followup (both nonsignificant).

The entire increment in Vitamin B_6 was accounted for by foods available in the WIC package, and by far the largest sources were WIC cereals (see Table V-4).

Vitamin B_{12}. No significant differences in total mean intake or frequency of low intake at study onset were associated with the WIC group. At followup, both WIC groups were consuming significantly more Vitamin B_{12} [(WIC group, 1.3 μg ($p < 0.05$); WIC/control group, 2.3 μg ($p < 0.05$)] than those who had been controls (2.3 μg, $p < 0.05$). The differences in Vitamin B_{12} from controls were entirely accounted for by foods available from the WIC package, mostly cereals (1.0 μg more than controls in the WIC group) but with a significant contribution from dairy foods as well (0.36 μg).

About 40 percent of controls had low intake of Vitamin B_{12} at the time of resurvey; 6.4 percent fewer women in the initial WIC sample had low intake ($p < 0.01$) and 9.9 percent fewer among those who had been controls ($p < 0.05$).

Vitamin C. There were no significant differences across study groups in either mean Vitamin C intake or in likelihood of low Vitamin C intake at registration into the study. Significant differences in mean intake at followup were associated with WIC (32.4 mg more than controls among the initial WIC sample [$p < 0.001$]; 29.8 mg more than controls among WIC/controls [$p < 0.01$]). At followup, 41.4 percent of controls had low

intake of Vitamin C. The rate among the WIC sample was 8.9 percent lower ($p < 0.001$), and in WIC/control women it was 9.5 percent lower ($p < 0.05$). Most of the increased intake was associated with increased nutrient density (see Volume IV, Appendix V-B-3). Differences in intake were attributable to foods available in the WIC package, mostly juices, but with a major contribution by cereals.

Maternal Risk Characteristics

This section describes subgroups of women defined by several characteristics, who were at risk of poor diet and who responded to WIC benefits. The risk characteristics studied were maternal age, height, cigarette smoking, ethnicity, marital status, education, income, and receipt of AFDC and/or Food Stamps. The relationship of WIC study group status to initial mean intake was estimated at registration into the study and at followup for all 15 nutrients. First, the duration of gestation was used to adjust at initial dietary recall and then all other covariates. At followup, the analyses were for intake adjusted for initial intake and duration of gestation and then also for the array of maternal characteristics at recruitment into the study. These were maternal characteristics ascertained before onset of participation in the WIC program and that therefore could not have mediated program effects. Dependent variables were total mean intake, total intake adjusted for caloric intake (nutrient density), and intake from potential WIC foods. Appendices V-B-6 to V-B-13 present results for all of these analyses. Table V-5 presents results only for total mean intake at followup, adjusted for all covariates, and only if at least one difference between either WIC group and controls was statistically significant within one or more of the strata defined by prior maternal risk and for eight key nutrients: energy, protein, calcium, iron, thiamin, Vitamin A, Vitamin B_6, and Vitamin C. Table V-5 presents mean intakes for control women, but only if there was at least one significant difference across the strata.

Maternal Age. Among controls, women under 18 had relatively high caloric and calcium intake. Increments associated with WIC for all nutrients under study were generally low among these youngest women. These small differences may be a function of the high intake among youngest controls for energy. However, this is not consistent with the significantly higher levels of iron, thiamin, and vitamin B_6 reported for the WIC/control group.

Maternal Height. Neither control group intake nor the increments in mean nutrient intake associated with the WIC program were consistently different by maternal height. There was no evidence that short women were particularly likely to report lower intakes..

Cigarette Smoking. Heavy smoking among controls was associated with significantly higher initial calorie intake (see Table V-6) and with significantly low nutrient density of protein, iron, and Vitamin C (see Appendix V-B-8). However, these heavy smoking controls (15+ cigarettes/day) had low energy intake at followup (1,773 kcal versus 1,923 kcal among non-

Table V-5

Total Mean Nutrient[a] Intake at Followup Interview Associated with an Array of Maternal Characteristics[b,c]

Risk	Energy (kcal) WIC at registration	Energy (kcal) Control at registration: WIC at followup	Energy (kcal) Control at registration: Controls at followup	Calcium (mg) WIC at registration	Calcium (mg) Control at registration: WIC at followup	Calcium (mg) Control at registration: Controls at followup	Iron (mg) WIC at registration	Iron (mg) Control at registration: WIC at followup	Iron (mg) Control at registration: Controls at followup
Age (y)									
<18	-23.3	268.8	2,063.5	-29.2	111.9	1,024.2	1.34	9.71**	14.11
18-19	202.0*	149.9	1,820.1	136.7*	131.1	853.5	4.06**	7.29**	13.16
20-29	94.3	33.8	1,918.2	146.1**	151.1*	861.2	3.39**	1.03	14.38
30+	148.1	431.6	1,839.9	194.3*	383.2*	830.9	2.24	6.26	14.42
Height (cm)									
<157.4	78.1	105.5	1,929.6	161.4**	181.6	827.2	3.33**	4.35*	13.61
157.4 - 162.6	105.3	153.8	1,896.3	142.0**	210.4*	845.5	2.82**	4.32*	13.78
162.7 - 167.5	48.9	60.6	1,966.4	77.4	105.8	957.2	3.16*	7.16**	14.57
>167.5	218.3*	243.5	1,834.0	133.9*	164.1	884.0	3.47*	2.29	14.64
Cigarettes/day (n)									
0	76.7	133.4	1,922.6	112.6**	134.6*	891.3	3.11**	4.15**	14.08
1-5	189.8	102.2	1,846.2	220.6*	326.2*	765.7	3.41	5.67	13.83
6-14	27.9	54.0	1,983.9	-4.1	131.4	1,002.8	2.24	7.30*	14.91
15+	324.6**	314.5	1,772.8	334.6**	338.1*	687.8**	4.38*	3.39	13.09
Ethnicity									
White non-Hispanic	135.7**	129.1	1,868.9	101.2**	141.9	949.8	3.29**	7.85**	13.85
White Hispanic	48.1	124.7	2,004.9	157.7**	271.7**	847.9	2.66	2.48	14.65
Black	128.3	171.2	1,900.2	170.0**	89.7	756.4**	3.31*	.86	14.08
Other	-48.0	34.2	1,888.2	254.2	406.2	688.5	2.69	4.49	13.70
Marital status									
Married	148.7*	129.8	1,872.2	177.7**	169.9*	845.4	3.55**	3.60*	13.54
Not married	65.4*	142.2	1,946.7	80.2**	160.9*	906.6	2.70**	5.17**	14.65
Education									
<12	112.5**	114.7	1,885.3	144.2**	233.4**	838.5	2.76**	4.92**	14.05
12+	113.9	204.4*	1,923.4	126.6*	88.8	900.9	3.61**	3.76**	14.11
Income (dollars/100)									
<3,000	-51.5	-16.8	2,060.1	104.4	120.5	941.9	2.91	3.89	13.85
3,000 - 6,999	91.0	228.1	1,873.2	110.4	218.7*	848.9	2.47	4.44*	14.69
7,000 - 12,999	114.1	143.7	1,925.6	110.5*	164.4	888.8	3.32**	4.09*	13.96
>13,000	212.5*	-44.0	1,862.6	194.1*	60.1	842.7	4.08*	2.99	13.32
Missing	181.0	207.3	1,867.0	194.4*	224.2	841.6	3.27*	6.26*	14.34
AFDC/Food Stamps									
Nonparticipant	111.5*	90.4	1,905.0	110.0**	136.4*	888.5	3.44**	3.81**	13.94
AFDC	68.7	-105.2	2,142.2	180.6	-625.2	995.3	5.07	-1.82	15.38
Food Stamps	145.0	268.0	1,873.4	190.7**	344.7**	804.2	2.55	8.60**	13.72
AFDC and Food Stamps	-8.6	189.5	1,968.5	176.2	150.7	819.1	.71	-.80	16.97

See footnotes at end of table.

(continued)

Table V-5 (continued)

Risk	Thiamin (mg): WIC at registration	Thiamin (mg): Control at registration: WIC at followup	Thiamin (mg): Control at registration: Controls at followup	Vitamin B_6 (mg): WIC at registration	Vitamin B_6 (mg): Control at registration: WIC at followup	Vitamin B_6 (mg): Control at registration: Controls at followup	Vitamin C (mg): WIC at registration	Vitamin C (mg): Control at registration: WIC at followup	Vitamin C (mg): Control at registration: Controls at followup
Age (y)									
<18	.12	.72*	1.53	.03	.64	1.79	20.3	43.1	118.4
18-19	.42**	.73**	1.36	.42**	.64*	1.50	24.4	77.2**	108.5
20-29	.36**	.23	1.43	.38**	.03	1.57	37.6**	9.6	110.4
30+	.29	.44	1.41	.29	.54	1.53	28.1	-24.0	124.5
Height (cm)									
<157.4	.26*	.39	1.44	.32*	.23	1.58	32.3*	54.5*	112.6
157.4 - 162.6	.38**	.43*	1.35	.30*	.26	1.54	23.7*	15.8	114.2
162.7 - 167.5	.25	.59*	1.55	.36*	.77**	1.63	36.8**	21.0	113.2
>167.5	.44**	.50*	1.39	.42**	.26	1.55	43.2	24.3	104.3
Cigarettes/day (n)									
0	.36**	.40**	1.41	.35**	.30	1.57	34.53**	20.66	115.29
1-5	.27	.73	1.45	.35	.50	1.52	16.60	36.34	111.44
6-14	.20	.71	1.53	.13	.71	1.78	35.77*	87.81*	98.61
15+	.47**	.44	1.27	.59**	.32	1.35	25.29	23.61	111.99
Ethnicity									
White non-Hispanic	.32**	.71**	1.41	.34**	.74**	1.54	30.1**	49.7**	99.8
White Hispanic	.35**	.38	1.43	.28	.13	1.69	35.7**	21.7	118.5
Black	.35**	.13	1.44	.41**	-.10	1.53	29.0*	6.7	130.8
Other	.40	.61	1.28	.28	.39	1.49	74.6*	46.4	98.1
Marital status									
Married	.39**	.41**	1.38	.38**	.23	1.54	38.8**	15.5	108.9
Not married	.28**	.51**	1.47	.30**	.44**	1.60	25.2**	41.0*	115.8
Education									
<12	.27**	.44**	1.46	.24**	.35	1.62	28.5**	37.8*	115.3
12+	.40**	.48**	1.39	.44**	.30	1.54	36.5**	14.9	108.2
Income (dollars/100)									
<3,000	.29	.50	1.41	.24	.11	1.59	46.7*	14.3	95.3
3,000 - 6,999	.28*	.39*	1.47	.28	.46	1.59	20.7	31.9	116.8
7,000 - 12,999	.37**	.54**	1.39	.42**	.41	1.52	41.0**	40.0*	108.7
>13,000	.42**	.29	1.35	.38	-.29	1.57	19.7	.2	121.2
Missing	.30*	.51	1.51	.33	.58	1.68	32.2*	37.2	119.0
AFDC/Food Stamps									
Nonparticipant	.36**	.47**	1.40	.36**	.31*	1.56	36.4**	30.6*	109.7
AFDC	.41	-.93	1.63	.31	-1.22	1.98	32.9	-95.9	119.0
Food Stamps	.31*	.69**	1.40	.35*	.79**	1.47	19.2	42.1	119.9
AFDC and Food Stamps	.09	-.04	1.68	.05	-0.32	1.90	31.3	4.8	112.6

See footnotes at end of table.

(continued)

Table V-5 (continued)

Risk	Vitamin A (IU): WIC at registration	Vitamin A (IU): Control at registration: WIC at followup	Vitamin A (IU): Control at registration: Controls at followup	Progein (g): WIC at registration	Progein (g): Control at registration: WIC at followup	Progein (g): Control at registration: Controls at followup	Number of subjects: WIC at registration	Number of subjects: Control at registration: WIC at followup	Number of subjects: Control at registration: Controls at followup
Age (y)									
<18	1,776.7	6,401.1**	4,739.8	-0.13	16.35	80.91	413	31	44
18-19	397.4	851.6	5,630.9	7.53	4.36	73.75	541	44	107
20-29	600.1	-483.0	6,494.3	4.42	-0.06	76.21	1,558	91	334
30+	1,994.8	1,469.7	6,033.9	11.37	28.29*	68.90	250	15	45
Height (cm)									
<157.4	2,049.9*	1,423.2	4,995.9				690	53	127
157.4 - 162.6	-98.6	-438.1	6,395.2				916	58	193
162.7 - 167.5	1,348.1	2,201.7	5,756.0				588	34	104
>167.5	190.7	1,866.4	7,279.7				548	36	166
Cigarettes/day (m)									
0	466.4	1,137.9	6,356.6	3.38	6.32	76.44	1,773	123	321
1-5	945.0	-145.6	5,526.5	9.79	1.72	72.74	251	20	53
6-14	-104.5	1,776.7	6,881.8	2.65	5.96	78.46	408	17	87
15+	3,180.8**	921.5	4,491.2	14.35**	12.50	69.70	330	21	69
Ethnicity									
White non-Hispanic				5.25*	4.54	74.24	1,372	73	300
White Hispanic				3.80	7.11	79.38	448	53	113
Black				8.73*	11.25	73.66	876	44	100
Other				-9.20	-6.66	78.81	66	11	17
Marital status									
Married				7.62*	5.68	74.22	1,260	86	296
Not married				2.39	6.48	77.42	1,502	95	234
Education									
<12	846.1*	2,112.7	6,001.1	6.49**	7.80	72.84	1,519	114	212
12+	789.9	-641.5	6,151.0	4.41	6.03	77.95	1,243	67	318
Income (dollars/100)									
<3,000	464.7	-227.4	6,141.5	-2.58	-0.123	81.92	885	57	116
3,000 - 6,999	982.8	1,252.2	5,747.8	7.69*	14.33*	71.80	447	23	51
7,000 - 12,999	-3.5	1,086.2	6,972.4	3.65	0.85	76.91	724	53	210
>13,000	2,255.5	1,281.5	5,175.2	6.53	-4.66	76.39	268	21	72
Missing	1,417.8	5,861.2**	5,540.2	10.10	17.12	73.48	438	27	81
AFDC/Food Stamps									
Nonparticipant	1,388.5**	372.7	5,605.3	5.07*	4.02	75.90	1,448	116	390
AFDC	-6,728.3*	-14,089.5	14,485.1***	1.50	11.37	88.66	103	1	14
Food Stamps	708.5	4,117.0*	5,933.0	6.57	13.74	73.47	786	41	108
AFDC and Food Stamps	-2,906.9	-1,675.1	9,720.3*	4.36	8.45	74.49	425	23	21

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]The nutrients here include energy, calcium, iron, thiamin, Vitamin B_6, Vitamin C, Vitamin A and protein.

[b]Followup interview was controlled for initial nutrient intake, duration of gestation at initial interview and at followup interview.

[c]Control group means and differences for WIC groups. ificance refers to differences from control group means. Reference group underlined. See Appendix V-A-1 for list of covariates.

Table V-6

Significant Differences Among Control Wo[illegible] in Mean Intakes[a] of Selected Nutrients at Registration and at Followup, Associated with Maternal Risk Characteristics[b]

Maternal risk characteristics	Energy (kcal) Registration	Energy (kcal) Followup	Calcium (mg) Registration	Calcium (mg) Followup	Thiamin (mg) Registration	Thiamin (mg) Followup	Vitamin C (IU) Registration	Vitamin C (IU) Followup	Vitamin A (IU) Registration	Vitamin A (IU) Followup	Protein (g) Registration	Protein (g) Followup	(n)
Height (cm)													
<157.5	1,934	1,930					117.8	112.6			76.7	73.8	127
157.5 - 162.5	2,075*	1,896					128.2*	114.2			82.6	74.3	193
162.6 - 167.5	1,829	1,966					98.6	113.2			75.5	79.3	104
167.6+	2,116*	1,834					130.0	104.3			87.6*	76.3	106
Cigarettes/day (n)													
0	1,900.6	1,922.6	867.3	891.3	1.37	1.41					77.3	76.4	321
1-5	1,987.0	1,846.2	917.1	765.7	1.49	1.45					83.5	72.7	53
6-14	2,244.4**	1,983.9	1,029.0*	1,002.8	1.77**	1.53					88.7*	78.5	87
15+	2,169.9*	1,772.8	1,013.0	687.8**	1.47	1.27					84.4	69.7	69
Ethnicity													
White non-Hispanic			1,044.8	949.8									300
White Hispanic			862.3*	847.9									113
Black			703.2***	756.4**									100
Other			901.9	688.5									17
Income (dollars/100)													
<3,000			935.6	941.9									51
3,000 - 6,999			1,059.7	848.9									116
7,000 - 12,999			916.0	888.8									210
>13,000			802.6**	842.7									72
Missing			835.4*	841.6									81
AFDC/Food Stamps													
Nonparticipant	1,946.1	1,905.0							5,860.5	5,605.3			390
AFDC	1,677.4	2,142.2							4,487.7	14,485.1***			14
Food Stamps	2,150.3*	1,873.4							5,568.5	5,933.0			108
AFDC and Food Stamps	2,003.8	1,968.5							5,807.3	9,720.3*			21

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Significance refers to differences from reference group (underlined).

[b]Maternal risk characteristics were used to stratify analyses presented in Table V-5 and Volume IV, Appendices V-B-6 through V-B-13. These were adjusted for full set of maternal characteristics (see Appendix V-A-3 for full covariate list).

smokers, [n.s.]). This low intake among heavy smokers was more than reversed among WIC recipient heavy smokers. Among controls, heaviest smokers generally had the lowest intake of all nutrients at followup except Vitamin C (see Table V-5). The magnitude of differences in mean intake associated with WIC was consistently and significantly greatest in heaviest smokers, except for Vitamin C. Thus, the WIC program appears to have been successful in affecting diets of heavy smokers (if not in affecting the rate of smoking).

Ethnicity. The effects of WIC program participation on mean nutrient intake appear to have been relatively independent of the ethnicity of the mother. What variability there was in caloric and calcium benefits seems to reflect more the variability of mean intake among controls than the intake levels of WIC recipients.

Marital Status and Education. The impact of the WIC program on mean nutrient intake may have been marginally greater among married and more educated women, at least in the initial WIC group. Differences, however, were small and would appear to have few implications for changes in WIC program design or implementation.

Family Income. Increments in mean nutrient intake associated with WIC program participation were somewhat greater among more affluent women, at least in the initial WIC group, although this was not true among WIC/controls.

AFDC and Food Stamps. WIC women (WIC and WIC/control) who did not receive AFDC or Food Stamps generally had significantly higher intakes of nutrients compared to women who did not participate in WIC or AFDC and Food Stamps (see Table V-5).

Discussion. These analyses suggest that WIC program effects on the nutrient intake in maternal diet during pregnancy were relatively uniform across groups defined by the maternal risk factors used. Thus, control women did not report that their diets were much worse if they were in particularly vulnerable groups, nor were the effects of WIC benefits much different given such group membership. Exceptions might be fewer benefits among pregnant women under 18 years of age, considered to be a particularly at-risk pregnancy age group, and greater benefits among heaviest smokers (15+ cigarettes/day).

Other Factors

While the central concern of this chapter is the relationship of WIC benefits to maternal diet, considerable information has been generated on the relationship between other maternal characteristics and initial nutrient intake and change in nutrient intake and on health care and other factors besides WIC that might influence change in intake between initial interview and followup. This section summarizes all significant regression coefficients from multiple regression analyses of initial total mean nutrient intake and from intake at followup, controlled for initial intake. (See Table V-7.)

Table V-7

Factors Significantly Related to Maternal [illegible] of Energy and Selected Nutrients at Registration and Followup
(Regression Coefficients from Multiple Regression Analyses[a])

		Nutrients											
		Energy (kcal)		Calcium (mg)		Iron (mg)		Vitamin C (mg)		Vitamin A (IU)		Protein (g)	
Regression coefficient	Units	Registration	Followup	Registration	Followup	Registration	Followup	Registration	Followup	Registration	Followup	Registration	Followup
Characteristics at onset of study:													
Nutrient at initial interview			.26***		.26***		.19***		.19***		.08***		.21***
Initial WIC sample, vs controls		-14.44	110.75**	43.35	132.67***	-.11	3.16***	5.24	32.43***	398.12	777.73	-1.14	5.22**
Initial controls, later WIC, vs controls		49.26	142.07*	3.06	172.51***	-.11	4.47***	9.33	29.84**	-258.51	1,023.49	-1.61	6.48
Duration of gestation at registration	(d)	1.15**	-1.21***	1.03***	-.83**							.04*	-.04*
Duration of gestation at followup	(d)	-		-	1.52*	-		-		-		-	
Age	(y)	-18.23***		-8.23*							139.17**	-.53*	
Parity	(n)				-29.14*						-453.03*		
Height	(cm)	5.10*		3.69*									
Cigarettes/day at registration	(n)	8.64***						-1.41***	-.67*			.21*	
White Hispanic, vs white non-Hispanic				-80.83*		1.29*		23.35***	21.13**				
Black, vs white non-Hispanic		98.99*		-217.88***	-139.56***			25.67***	27.77***	1,173.30**	1,381.40***	4.98**	
Other ethnic group, vs white non-Hispanic		192.98*			-122.94*								
Income	($/100)	1.39**										.04*	
Household size	(n)								-2.81*	-258.69**	-192.97*	-.95*	
AFDC	(yes=1)						1.48*						
Foodstamps	(yes=1)	83.70*											
Mother employed, vs housewife, student, disabled				-236.08**							3,217.76*		

See footnotes at end of table.

(continued)

Table V-7 (continued)

Regression coefficient	Units	Energy (kcal) Regis-tration	Energy (kcal) Followup	Calcium (mg) Regis-tration	Calcium (mg) Followup	Iron (mg) Regis-tration	Iron (mg) Followup	Vitamin C (mg) Regis-tration	Vitamin C (mg) Followup	Vitamin A (IU) Regis-tration	Vitamin A (IU) Followup	Protein (g) Regis-tration	Protein (g) Followup
Hours worked at registration	(h)	6.85*		8.04***								.27*	
Mother farmworker[b]			274.35*										15.07**
Mother sales worker[b]		90.77*		63.17*							801.71*	4.51*	
Mother professional[b]		182.71*	181.57*								2,795.24**	8.60*	9.01*
Mother never worked[b]													3.76*
Father farmworker[b]		155.88*				2.09**						9.22**	15.07**
Father sales worker, skilled trade, clerical[b]										1,157.65**			
Fathers education	(y)								2.50*				
Mother's diet not usual at registration		-174.33***	120.79***	-119.58***	53.95**	-1.36***	1.06*	-25.12***		-1,180.33***		-9.68***	3.96**
Mother's diet not usual at followup		-	-276.80***	-	-164.37***	-	-3.07***	-		-		-	-13.97***
Changes during study participation:[1]													
Mother's diet affected by nutrition education versus not affected		-		-	49.00*	-		-		-		-	3.89*
Nutrition education given by non-WIC health staff versus anyone else		-		-		-	1.60*	-		-		-	
Cigarettes/day at followup	(n)	-		-		-		-		-	-96.28**	-	

*p < 0.05.
**p < 0.01.
***p < 0.001.

n = 3,472 (2,762 WIC, 180 WIC/control, 530 control).

- = not applicable.

[a]Regression coefficients from multiple regression analyses adjusted for maternal risk characteristics at registration into study and changes during study participation. See Volume IV, Appendix V-A-3, for full covariate list including changes during study participation. Regression coefficients for changes during study from regression analysis in which these factors were included in addition to maternal characteristics at registration.

[b]Versus physical labor, service, manufacturing.

Energy. Energy intake at initial interview was significantly related to the following maternal characteristics: black ethnicity (99 kcal more than whites, $p < 0.01$), maternal age (18 kcal fewer with each year increase in age, $p < 0.001$), height (5 kcal more with each centimeter of height, p < [illegible]), work in skilled trade or sales (91 kcal more than those in physical labor, service occupations, or manufacturing, $p < 0.05$), professional occupational status (183 kcal more than those doing physical labor or in manufacturing or service occupations, $p < 0.05$), husband a farm worker (156 kcal more than if the husband is in physical labor, service, or manufacturing, $p < 0.05$), number of hours of maternal work (7 kcal/day greater with each increased hour of work per week, $p < 0.05$), smoking (9 kcal more for each cigarette smoked, $p < 0.001$), and receipt of Food Stamps (84 kcal/day more than those not receiving Food Stamps, $p < 0.05$). If the woman reported that the intake for the day in question was unusual, she consumed 174 fewer calories ($p < 0.001$), and intake was 1.1 kcal greater per day as the duration of gestation at the time of recall increased ($p < 0.01$).

At the followup visit, energy intake (adjusted for initial intake and thus equivalent to change in energy intake from initial intake) was significantly related, in addition to WIC program participation, initial intake, and duration of gestation at initial interview, only to the mother's being a farm worker (274 kcal more, $p < 0.05$) or a professional (182 kcal more, $p < 0.05$), both compared to women in physical labor, service, or manufacturing, and to whether the intake for the index day was considered unusual.

Thus, while numerous maternal characteristics were associated with initial intake, increased energy intake during pregnancy was far less predictable and WIC program participation stands out as one of the few significant associations (and presumably one of the few determinants) of increased energy intake. This is important since mean energy intake was far below recommended levels in the study population, as in all current dietary surveys of young American women, whether pregnant or not.

While over the course of pregnancy their increments in skinfold thickness and weight gain were lower than those of whites, black women did not report lower calorie intake. This also was true of smokers: while they reported greater calorie intake at initial visit, at followup they had low weight gain and thin skinfolds.

Protein. Initial protein intake was significantly related to the following maternal characteristics: gestational age, black ethnicity, family income, smaller household size, younger age, number of hours of maternal work per week, work in sales or service or professional occupation (vs. physical labor, service, or manufacturing), husband is a farmer, and cigarette smoking (see Table V-7). (This set of factors was similar to those for caloric intake.) Increased protein density at initial interview was significantly and negatively related to cigarette smoking (0.12 g less per cigarette smoked, $p < 0.05$) and positively related to lack of available kitchen facilities (5.12 g more, $p < 0.05$).

At followup, increased protein intake during pregnancy, in addition to WIC program participation, was related only to the mother's being in farm or professional work or never having worked (compared to women in physical labor, service, or manufacturing occupations), whether the recall was considered unusual, and the stage of gestation at interviews (although for duration of gestation, it was in the opposite direction from that observed in the initial interview). The relationship of change in reported intake was significant if the mother stated that nutrition education had affected the way she was eating (3.9 g/day more, $p < 0.01$). Protein density at followup was significantly related to greater maternal education (0.63 g/yr of education, $p < 0.01$), smaller household size (0.67 g less, $p < 0.01$), the woman's never having worked (2.97 g, $p < 0.01$), whether the woman reported that her eating was affected by nutrition education (2.3 g, $p < 0.05$), and whether the woman's eating was negatively related to smoking at followup (0.20 g less per cigarette smoked, $p < 0.05$).

Calcium. Initial calcium intake was associated with much the same set of maternal characteristics as caloric intake, with several marked exceptions. While blacks consumed more calories than whites, they ate much less calcium (218 mg/day, $p < 0.001$), which may reflect the higher frequency of lactose intolerance among blacks. Hispanics also consumed less calcium than whites (81 mg, $p < 0.05$), and the unemployed ate far less calcium than those working (236 mg, $p < 0.01$). Women farm workers followed more calcium-dense diets (165 mg, $p < 0.01$), and the calcium density of the initial diets also was associated with amount of time worked each week (5 mg, $p < 0.01$).

At followup, the change in calcium intake from the initial recall was significantly lower among blacks, those of "other" ethnicity, and women of higher parity. Calcium intake was higher if the woman reported that nutrition education affected her eating. The frequency of prenatal visiting was positively related to increased calcium intake, but not at conventional levels of statistical significance ($p = 0.07$). The relationship with calcium density, however, was significant (5 mg, $p < 0.05$).

Iron. Initial iron intake was significantly related only to Hispanic ethnicity (1.3 mg more than whites, $p < 0.01$), and the husband working on a farm (2.1 mg more than if he worked in physical labor, service, or manufacturing, $p < 0.01$). In addition, the iron density of the diet was negatively related to smoking (0.06 mg less per cigarette smoked, $p < 0.001$).

Increased iron intake during pregnancy was very strongly related to WIC and otherwise only to receipt of AFDC (1.5 mg more than others, $p < 0.05$), and to receipt of nutritional counseling from a (non-WIC) health professional, compared to no counseling (1.6 mg, $p < 0.01$).

Vitamin A. Given both the relatively high rates of low intake (over half the study population) and absence of any significant relationships between WIC benefits and Vitamin A intake, the pattern of maternal characteristics associated with Vitamin A intake is of interest and concern. Initial Vitamin A intake was significantly related to the following char-

acteristics: black ethnicity (1,173 IU/day more than whites, $p < 0.01$), smaller household size, and father working in a skilled trade or sales (versus physical labor, service, or manufacturing). Vitamin A density was negatively and significantly related to the number of cigarettes smoked daily (59 IU less per cigarette smoked, $p < 0.01$).

At followup, an increase in Vitamin A intake was associated with black ethnicity, smaller household size, lower parity (but older age), work in sales or skilled trade or professional occupations, and employment. The amount smoked at followup was negatively related to change in Vitamin A intake. Thus, smokers, higher parity women, those at home, and those not working were all likely to have lower Vitamin A intakes.

Vitamin C. Initial intake was higher among both blacks (25.7 mg, $p < 0.001$) and Hispanics (23.4 mg, $p < 0.001$) than among whites and was negatively related to smoking (1.4 mg less/day per cigarette, $p < 0.001$). At followup, increased intake over initial levels was greater among Hispanics and blacks, those with smaller household size, and those with greater paternal education and was lower with amount smoked.

Conclusions

The WIC program achieved significantly increased intakes of four of its five targeted nutrients: protein, iron, calcium, and Vitamin C. Only Vitamin A was not significantly affected. In addition, there were significant increments in energy, magnesium, phosphorus, thiamin, riboflavin, niacin, Vitamin B_6, and Vitamin B_{12}.

The reported levels of incremental energy and protein intake achieved by the WIC program are of the same order of magnitude as in smaller, intensive, clinical, controlled trials of nutritional supplementation in pregnancy. Except for Vitamin A, the WIC program appears to have met all reasonable goals in improving the diets of the poor pregnant women it serves.

Certain elements of classical experimental study design could not be attained in a survey such as this one. For instance, it was impossible to blind observers to the study status of those in the initial WIC sample. On the other hand, the dietary history of control women who enrolled in the WIC program (WIC/controls) between registration and followup was taken before the set of questions were completed that identified the women as having enrolled in the WIC program. While the number of such women (in this analysis, 181) was not large, the remarkable similarity of their dietary intake with that of the larger initial WIC sample strongly suggests that these results are not a function of observer bias. Further, to the extent that field operative inexperience with dietary instrumentation led to measurement error, the effect would have been to increase variance and decrease the opportunity to detect differences between groups, rather than to exaggerate them.

These results, therefore, appear to be credible, secure, and consistent with important nutritional benefits. Most of the benefits arose from

increased nutrient density rather than from an increase in the overall dietary intake, although the increase in caloric intake also was significant bringing women closer to Recommended Daily Energy intakes. The totality of benefits is accounted for by the WIC program package, and most of the benefits were ascribable to food, rather than to other mediating factors, such as nutrition education. However, the dietary benefits associated with these latter changes were not trivial.

C. ANTHROPOMETRY AND HEMATOLOGY

1. Introduction

This section summarizes the effects of enrollment in the WIC program on changes in maternal weight, arm circumference, and triceps and subscapular skinfold thicknesses for the total study population of women and for groups of women stratified by various maternal risk characteristics. Anthropometric changes also are related to duration of benefits of the WIC program. The section also summarizes the effect of factors other than the WIC program on changes in anthropometric indices and whether changes associated with WIC were mediated by energy intake and responsiveness to nutritional advice, change in use of alcohol and tobacco, and change in patterns of work.

The measurement of change in maternal anthropometry during pregnancy is considered important for several reasons. Maternal weight gain may be influenced by supplemental feeding and is an outcome variable as well as a mediating variable for fetal growth.

Changes in maternal skinfold thickness during pregnancy were measured for many reasons: measurements are noninvasive; they are an index of energy stores, and fat is theorized to be the only form of maternal macronutrient storage during pregnancy (Hytton and Leitch, 1971); their measurement is considered to be a component of good nutritional survey methodology; they serve to confirm theories of how nutrition affects the fetus; and they are additional measures of body change during pregnancy.

In addition to maternal anthropometric changes, WIC program participation is related to initial hemoglobin concentration and to changes in hemoglobin concentration over the course of pregnancy. Iron status, specifically the presence of anemia, is a criterion for certification in the WIC program and may therefore serve as a possible measure of WIC program effectiveness. Studies of pregnant women receiving iron supplements have shown that declining hemoglobin values may be ameliorated with supplementation.

The results of this longitudinal study of nutritional supplementation and education in pregnancy, one of the largest ever undertaken and reported, are certain to provoke discussion, speculation, and further research. Further research will be required both to specify the biological mechanisms and to better understand the effects and benefits of nutritional supplementation during pregnancy.

2. Analytic Methods

Anthropometric Measures

Maternal Weight and Weight Gain. Seven linear multiple regression analytic models were developed to assess maternal weight and weight gain in pregnancy. In each of them, maternal weight was contrasted among 3,576 women who were initially recruited into our nationally representative WIC sample, and 214 control women who before reinterview were enrolled into the WIC program, with 598 control women. Excluded from this analysis were all women for whom there were no paired weight measurements, diabetic women, women who delivered multiple births, or women whose infants had severe congenital anomalies probably associated with growth retardation. (All covariates are specified in Volume IV, Appendix V-C-1, and specimen multiple regression analyses are presented as Appendices V-C-2. See Appendix V-C-3 for a list of exclusions.)

The seven regression analyses for maternal weight and weight gain were:

1. Maternal weight at initial interview adjusted only for duration of gestation at that interview.

2. Maternal weight at initial interview adjusted for 36 more variables describing differences in maternal characteristics at the time of first interview that might have affected outcomes. These included maternal age; parity; height; ethnicity; smoking; alcohol intake; marital status; whether working; number of hours worked; number of hours of work while standing; level of exertion of work; receipt of welfare, Medicaid, and Food Stamps; occupational and employment status of both parents; family income; and household size.

3. Weight at initial interview adjusted for mother's reported weight at conception and duration of gestation at registration. This analysis, therefore, is of the rate of gestational weight change from conception to registration.

4. Weight at registration adjusted for weight at conception and all other covariates as in (2), above.

5. Weight at followup visit late in pregnancy adjusted for duration of gestation at initial weight, at revisit, and weight at initial visit. This, therefore, represents weight change while the woman was enrolled in the study.

6. Weight at followup visit controlled for the same variables as in (5) and in (2) above, i.e., characteristics of the mother at the time of registration, including weight at conception and weight at registration. This regression model, therefore, is the full-

est statement of the WIC program's effect on maternal weight gain. It adjusts for a variety of potential confounding factors but does not include experience of the mother after registration that might have mediated some of the weight gain difference. Unless otherwise specified, this is the weight at followup visit referred to in the text.

7. Weight at followup visit, but in addition to all covariates in model (6) above a set of variables that potentially mediated the effects of the WIC program, e.g., change in employment status, hours worked, hours standing at work, level of exertion at work, change in smoking and in alcohol intake, and change in reported caloric intake. Thus, this set of variables includes characteristics that could have been affected by the WIC program and hence might have mediated some of the change associated with the WIC program. The effects of the program were compared with and without the presence of the mediating variables to estimate the extent to which WIC effects were mediated by these factors.

Arm Circumference, and Triceps and Subscapular Skinfolds. Five linear multiple regression analyses were developed for the assessment of arm circumference, as well as for both triceps and subscapular skinfold thicknesses. The first two analyses are for values at the intial interview, and the last three analyses are for values at the followup visit.

1. Maternal arm circumference (or triceps or subscapular skinfolds) at initial interview adjusted only for duration of gestation at that interview.

2. Arm circumference (or triceps or subscapular skinfolds) at initial interview adjusted for the large set of covariates describing maternal status at registration into the study.

3. Arm circumference (or triceps or subscapular skinfolds) at followup visit late in pregnancy adjusted for the duration of gestation at followup, initial value, and duration of gestation at the time of initial measurements.

4. Arm circumference (or triceps or subscapular skinfolds) at followup visit adjusted for maternal characteristics known at registration into the study (the results of this analysis that are referred to in the text, unless otherwise specified).

5. Arm circumference (or triceps or subscapular skinfolds) at followup visit adjusted further for variables potentially mediating WIC effects. While weight at conception was controlled in the larger models, weight at initial interview was not.

Maternal Risk Characteristics

WIC enrollment was related to maternal anthropometric status within strata of women defined by various maternal risk characteristics. The full set of analyses, both partially and fully adjusted, for status at both enrollment and followup visit are presented as Volume IV, Appendix V-C-4. Basically, there are four sets of regression models:

1. Maternal anthropometry and a selected risk characteristic by WIC, WIC/control, and control at initial interview controlled for duration of gestation at registration into the study.

2. Maternal anthropometry and a selected risk characteristic by WIC, WIC/control, and control at initial interview controlled for both duration of gestation and the full set of maternal characteristics at registration into the study.

3. At followup, anthropometric measures and a selected risk characteristic controlled for duration of gestation at both interviews.

4. At followup, as in (3) with added control of the full set of maternal risk characteristics.

Duration of WIC Benefits

The duration of WIC benefits was related to changes in anthropometric indices by regression analyses in which study group membership (initial WIC, WIC/control, and control groups) interacted with the length of time between initial and followup interviews with control for duration of gestation at initial interview and measurement and also further adjustment for the full covariate set. The regression models included the initial measurement at recruitment into the study of the index in question (i.e., weight, arm circumference, triceps skinfold, or subscapular skinfold), as well as the full set of covariates (see Appendix V-C-1), but excluded weight at recruitment and followup other than in the analysis on weight.

State WIC Directors' Assessment of Quality of Local WIC Program Effectiveness

The development and usage of the State WIC Directors' evaluation of local WIC program performance are described in Chapter IV. These scores were applied to changes in maternal anthropometric status among all women with both perinatal and late pregnancy data to judge whether the perception of quality of the WIC program was related to changes in anthropometric indices and also whether such change might be one of the mediating mechanisms by which quality of program influences perinatal outcome.

Hematologic Measures

Maternal Hemoglobin and WIC Benefits. In these analyses, initial hemoglobin concentration (which could have been assessed before, at, or

after WIC program recruitment) was first adjusted only for duration of gestation and WIC status and then also for a wide variety of maternal characteristics. These analyses were repeated for final prenatal hemoglobin concentration with adjustment for the initial hemoglobin level and duration of gestation at followup measurement.

Maternal Risk Characteristics. The multiple regression analyses were run on:

- The earliest hemoglobin concentration associated with the current pregnancy with the full set of maternal risk characteristics collected during the initial interview.

- The last hemoglobin concentration with the same set of characteristics (in addition to whether iron supplements were given) were used to assess the relationship of factors other than WIC enrollment to initial hemoglobin level and change during pregnancy.

3. Results

Results of anthropometric and hematologic analyses are confined to the 4,561 women who were reevaluated in late pregnancy and who were first evaluated before the 28th week of pregnancy: 3,619 in the group of initial WIC recruits and 942 controls of whom 225 enrolled in the WIC program subsequent to recruitment into the study (WIC/controls) and 717 who did not (controls). This last group is the reference group in all analyses; the outcomes for the initial WIC sample of women and for WIC/controls will always be compared to them separately.

Anthropometric Measures

Maternal Weight and Weight Gain. The mean maternal weight at initial visit and revisit for the group of women who remained controls and the differences in weight among controls, WIC/controls, and WIC women are presented in Table V-8. When adjustment was made only for duration of gestation at initial interview, the women in the WIC sample were 0.12 kg heavier than controls at initial interview and those who were later enrolled in the WIC program were 1.52 kg lighter. Neither of these differences was significant, and with full adjustment these differences were reduced slightly. Adjusting for weight at conception changes these relationships dramatically. After adjustment for weight at conception, the WIC group was 0.72 kg lighter than controls at initial interview ($p < 0.01$) and the group of women who had been controls but who were enrolled in the WIC program were 0.87 kg lighter ($p < 0.05$). Thus, the WIC program selectively recruited women who had low gestational weight gain at program entry, but who were generally heavier than controls at conception.

Full adjustment for all maternal characteristics at registration barely affects these estimated differences. This is important since sociodemographic differences across study groups, which certainly exist, do not

Table V-8

Maternal Weight, Arm Circumference, and Triceps and Subscapular Skinfold Thickness[a]

Measurement	WIC Status: WIC at registration	Controls at registration: WIC at followup	Controls at registration: Controls at followup
Weight (kg)			
Initial			
Partially adjusted[b]	0.12	-1.52	65.25
Adjusted[c]	0.08	-1.03	65.26
Partially adjusted with weight at conception	-0.72**	-0.87*	65.90
Adjusted with weight at conception	-0.72**	-0.70	65.89
Followup			
Partially adjusted	-0.13	-0.18	72.27
Adjusted	0.07	-0.27	72.11
Adjusted, with mediation	0.00	-0.31	72.17
N	3576	214	598
Arm circumference (cm)			
Initial			
Partially adjusted	0.35	-0.10	27.14
Adjusted	-0.04	-0.08	27.45
Followup			
Partially adjusted	-0.01	-0.04	28.01
Adjusted	-0.01	0.03	28.00
Adjusted, with mediation	-0.06	0.06	28.05
N	3655	218	614
Triceps skinfold (mm)			
Initial			
Partially adjusted	-0.58	-0.65	20.82
Adjusted	-0.47	-0.36	20.71
Followup			
Partially adjusted	-1.00***	-0.32	22.59
Adjusted	-0.90***	-0.37	22.51
Adjusted, with mediation	-0.87***	-0.38	22.48
N	3619	218	612
Subscapular skinfold (mm)			
Initial			
Partially adjusted	-0.10	0.44	17.60
Adjusted	-0.30	0.51	17.75
Followup			
Partially adjusted	-0.81***	-0.37	20.87
Adjusted	-0.80***	-0.21	20.85
Adjusted, with mediation	-0.75**	-0.22	20.81
N	3579	216	601

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a] Control group means and differences for WIC groups. Significance refers to difference from control group mean.

[b] Partial adjustment for duration of gestation at initial and followup measurements.

[c] Further adjusted for changes potentially initiated by WIC program (change in alcohol, smoking, and frequency and exertion in work).

appear to be the origin of the differences associated with WIC enrollment, and thus, if sociodemographic differences could be better adjusted, extensive further change in results would be unlikely. It follows that women recruited into the WIC program had gained significantly less weight during early pregnancy (the mean duration of gestation at registration into the study was 126 days) than had controls. This is likely to be a slight underestimate: maternal weight gain in early pregnancy is not linear but accelerates after the end of the first trimester. Since the initial WIC group was enrolled 10.7 days later in gestation than control women, the weights of the WIC group would likely appear higher than appropriate with linear adjustment, and the control group lower.

These results are consistent with the selection of women into the WIC program having lower weight gain than those in the general population from which they are drawn and with the fact that the program is recruiting women who are more likely to need nutritional services in pregnancy. A difference of 0.7 kg at 18 weeks pregnancy is not trivial. The usual estimate is that average weight gain is approximately 1.5 kg in the first trimester of pregnancy and then a little under 0.5 kg/week subsequently. Therefore, the expected mean weight gain at 18 weeks would be a little under 3.5 kg. A decrement of 0.7 kg might represent about a 20-percent reduction among WIC women. In fact, the actual mean weight at registration was 65.3 kg, and the related weights at conception were 61.2 kg, a difference of 4.1 kg. Thus, 0.7 kg represents an actual 17-percent reduction among women in the WIC group.

By followup visit, maternal weight among women who were enrolled in the WIC program at the onset of the study was no longer depressed; their weight in the fully adjusted regression model was actually higher than that of residual controls. Thus, while at the time of enrollment their weight gain was low, from that point on their gain was comparable to that of controls. These results are consistent with an interpretation that the WIC program led to a reversal of the depressed weight gain among these women and brought their gain up to the same rate as that of controls. Women who had been controls but who were enrolled in the WIC program before followup visit were at intermediate levels: while they had been 0.70 kg lighter than controls at initial visit after adjustment for weight at conception (n.s.), they were only 0.27 kg lighter at revisit. This is consistent with an intermediate effect consequent on intermediate duration of program exposure. Regression to the mean could account for some narrowing of initial differences, but not the complete reversal of initial low weight gain. Thus, the program appears to have intervened successfully in a group of women who had been gaining significantly less weight in early pregnancy up to the time of recruitment into the WIC program and to have brought their rate of gain up to the level of controls.

Some doubt may be cast on these analyses because of the unreliability of the mothers' report of weight at conception. Of course, direct measurement was impossible, since women could not be followed from before conception, but only from the time they entered the WIC program or first sought prenatal care. Such doubt arises because of the imprecision in the moth-

ers' reported past weights. However, it is unlikely that uncertainty in the accuracy of the infant weight at conception could lead to increased differences across study groups. Rather, if the mothers' reports were, in the extreme case, random, any real differences would be obscured since the reported weights would be unrelated to actual weights. The effects of adjustment with unreliable histories should be less than effects of adjustment for true values. Only if reporting were biased (e.g., only WIC women systematically reported that their weights at conception were higher than they actually were) would the observed relationships be explained by historical inaccuracy. There seems no logical reason that this should have happened.

Arm Circumference. As summarized in Table V-8, neither arm circumference at initial evaluation nor that at followup was significantly associated with WIC benefits.

Triceps and Subscapular Skinfolds. There were strong associations between WIC program enrollment and change in skinfold thickness from initial recruitment to late pregnancy followup and some difference in the effects on the peripheral (triceps) and truncal (subscapular) skinfolds, as summarized in Tables V-8 and V-9. There were no significant relationships between enrollment in the WIC program and skinfold thickness at registration into the study, although both the triceps and subscapular skinfolds were slightly lower among women in the initial WIC sample and WIC/control women than among control women.

It was quite unexpected that WIC would be associated with a highly significant depression in change in thickness of both skinfold sites between registration and followup. Adjusting for the initial skinfold thickness, as well as all other covariates, the triceps skinfold in women in the initial WIC group was 0.90 mm less than that of controls ($p < 0.001$) and the subscapular skinfold was 0.80 mm less ($p < 0.01$). The direction of difference was the same for control women who enrolled in the WIC program before followup visit, but the magnitudes were less and differences were not significant. The estimated differences from the regression models adjusted only for duration of gestation at evaluation were barely different from the fully adjusted differences, so the observed results were very unlikely to be a function of confounding, at least by maternal characteristics that were identified. For the moment, one must accept that women enrolled in WIC had less increase in skinfold thickness than controls between registration and late pregnancy, and this appears to have been caused by WIC program participation. Had the partially adjusted differences been much reduced by further adjustment, one might speculate that if the covariate set were more complete, better measured, or more appropriately chosen, the entire difference might disappear. However, the difference between the unadjusted and adjusted values was small.

The assumption that led to inclusion of skinfold measures in the study was that the WIC program would lead to increased and improved maternal dietary intake (which was demonstrated; see Section B), which in turn would lead to accelerated weight gain and deposition of greater maternal energy

Table V-9

Maternal Anthropometric Measurements at Followup Controlled for Initial Measurement. Relationship to WIC, and Other (Statistically Significant) Maternal Risk Characteristics.[a] (Regression Coefficients, and Significance Level from Multiple Regression Analyses)

	Weight (kg)	Arm circumference (cm)	Triceps skinfold thickness (mm)	Subscapular skinfold thickness (mm)
Initial measurement at enrollment	0.826***	0.092***	0.696***	0.705***
WIC at registration vs. control at followup	0.065 n.s.	0.008 n.s.	-0.899***	-0.797***
Control at registration, WIC at followup vs. control at followup	-0.272 n.s.	-0.031 n.s.	-0.374 n.s.	-0.212 n.s.
Weight at conception (kg)	0.118***	0.213***	0.090***	0.097***
Height (cm)	0.075***	-0.076***		-0.029*
Black (vs. white)	-0.538**	-0.518*	-1.039***	-0.667**
Cigarettes/day (n)				
at registration	-0.051***	-0.029*	-0.043***	-0.045***
at followup	-0.044**			
Duration of gestation (d)				
at registration	-0.041***			-0.014***
at followup	0.003***	0.022***		
Caloric intake (kcal × 100)				
at registration	0.019*	0.029*		
at followup		-0.038**		
Vomiting (d)	-0.003*			
Parity (n)	-0.451***			
Prenatal health care visits (n)	0.053*	0.068*		
Father's education (yrs)		0.105*		

See footnotes at end of table.

(continued)

Table V-9 (continued)

	Weight (kg)	Arm circumference (cm)	Triceps skinfold thickness (mm)	Subscapular skinfold thickness (mm)
Father employed vs. father never worked		0.560**		
Father retired, in jail, deceased, student, disabled, vs. father never worked		0.874**		
Previous low birthweight infants (n)			-0.361*	
AFDC (y=1)			-0.596*	-0.494*
Mother works in sales, skilled trade, clerical, vs. physical labor, service, manufacturing			0.421*	
Mother never worked vs. physical labor, service, manufacturing	-0.438*			
Medicaid (y=1)			0.761***	
Past stillbirth (y=1)				-1.855**
Mother's education (y)				-0.119*
Family income (dollars/100)				-0.004*
Father never worked vs. physical labor, service, manufacturing				-0.505*

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]See Volume IV, Appendix V-C-1, for full covariate list.

stores. In fact, what occurred was that initially decelerated weight gain in the WIC sample was reversed, but energy stores, rather than being laid down and maintained, were lower in the WIC group in late pregnancy. While this result is counterintuitive, it is somewhat reassuring to know of no study as large as this one that has measured longitudinally energy deposition in pregnancy in relationship to nutritional supplementation and thus that would have been able to detect the nature and level of differences observed.

Enrollment in the WIC program may have led therefore to either less energy deposition or greater mobilization, or both. Without interim serial measurements, however, it is impossible to say which is more likely. One can only speculate on how energy intake was used. Possibly, it was used to metabolize the more nutrient-dense diet that women in the WIC program were following and thus associated with increased metabolic rate. Another possibility is that the energy was put to use by increased maternal activity, by the laying down of new maternal tissue, or in the growth or metabolism of the products of conception. The magnitude and statistical significance of these results leave little doubt that they were very unlikely to have been artifactual or chance occurrences. Their origins and health and physiologic importance must await further elucidation.

Maternal Risk Characteristics

Table V-10 summarizes changes between study registration and late pregnancy for anthropometric status adjusted for all covariates (including initial measure), but only where at least one WIC control difference in the set was statistically significant.

Only stratification by family income yielded a significant WIC/control difference in weight gain. Lowest income WIC recipients (family income under $3,000/yr), whether initial or later recruits, gained significantly more weight than lowest income controls whose weight was about a kilogram lower than any other economic stratum of control women and significantly lower than the control reference group of women with family incomes between $3,000/yr and $7,000/yr. The significant control group and WIC/control differences must be interpreted cautiously, since the weights from these groups were from relatively small samples of these poorest women.

The only significant WIC/control difference in arm circumference at followup visit was among the 18 women of parity greater than two who were initial controls, but who later enrolled in the WIC program, compared to the 62 women who were controls. Although obvious outliers were not included in the analysis, this 6.5 cm difference is suspect, especially when the difference between initial WIC recruits and residual controls was only 0.5 cm (and was not significant).

The results for triceps and subscapular skinfolds were very different: significant differences were associated with WIC in almost all analyses, but the patterns of WIC/control difference were dissimilar for the two sites.

Table V-10

Maternal Anthropometric Status at Followup Controlled for Initial Measurements and Maternal Risk Characteristics[a]

Maternal risk characteristics	Weight (kg)			Arm circumference (cm)			Triceps skinfold (mm)			Subscapular skinfold (mm)			Sample size (n)[b]		
	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control
Age (y)															
< 18							-1.32	-0.75	23.46	-0.09	0.68	20.90	572	34	59
18 - 19							-0.23	0.89	22.22*	0.19	0.96	20.41	674	53	135
20 - 29							-1.54**	-1.12*	23.31	-0.81**	-0.57	21.24	2012	115	438
30+							-1.87*	-2.09	23.72	-2.96**	-1.48	22.88*	318	19	63
Parity (n)															
0				0.35	-1.13	28.35	-0.69*	-0.02	22.65	0.03	0.32	20.73	1579	109	321
1 - 2				0.22	-0.17	27.81	-1.65**	-0.89	23.48	-1.13**	-0.31	21.48	1622	94	312
> 2				0.60	6.60**	28.47	-2.48**	-3.63*	24.05	-2.71**	-1.98	22.41	375	18	62
Previous low birthweight (multiparae only)															
Parity 0							-0.72*	-0.05	22.62	-0.03	0.28	20.68	1579	109	315
No							1.74**	-1.22	23.67	-1.37**	-0.48	21.72*	1588	93	313
Yes							-1.78*	-1.56	23.29	-1.08	-0.81	21.32	423	20	67
Weight at conception (kg)															
< 50.35							-1.41**	-1.70**	21.92	-0.16	0.79	19.20	720	52	171
50.35 - 63.49							-1.07**	-0.45	22.58	-0.32	0.34	20.46	1650	104	312
> 63.5							-1.30**	-0.48	24.57**	-1.71**	-1.83*	23.52**	1206	65	212
Height (cm)															
< 157.4							-2.14**	-1.19	24.17*	-0.83	0.14	21.75	885	65	151
157.4 - 162.6							-1.03**	-2.11**	23.10	-0.94**	-0.83	21.31	1229	74	261
162.7 - 167.5							-1.66**	0.37	22.85	-0.52	-0.29	20.63	746	35	135
> 167.5							-0.45	0.95	22.39	-0.48	0.42	20.80	716	47	148
Quetelet's index at conception (kg x 100/cm²)															
< .19							-1.22*	-1.36	21.81*	0.61	1.57	18.79**	598	43	134
0.19 - 0.27							-1.29**	0.08	23.01	-0.79**	0.26	21.10	2299	141	447
> .27							-1.22*	-3.12**	24.78**	-1.83**	-4.06**	23.93**	79	37	114
Cigarettes/day (n)															
0							-1.75**	-1.52**	23.84	-1.20**	-0.59	21.85	2330	154	426
1 - 5							-0.98	2.12	22.77	0.11	1.06	20.34	319	22	63
6 - 14							-1.11*	-1.51	22.42*	-0.53	-0.80	20.64	508	20	108
15+							0.33	1.16	21.24***	0.53	1.06	19.46	419	25	98
Alcohol/week (oz.)															
0							-1.30**	-0.78	23.16	-0.67**	-0.15	21.17	3269	201	625
< 2							-1.52	-3.12	23.65	-1.54	-1.23	21.18	205	13	48
2+							-1.03	4.85*	21.75	-1.13	1.16	21.20	102	7	27

(continued)

Table V-10 (continued)

Maternal risk characteristics	Weight (kg)			Arm circumference (cm)			Triceps skinfold (mm)			Subscapular skinfold (mm)			Sample size (n)		
	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control	WIC	WIC/ control	Control
Marital status															
Married							-1.42**	-1.86**	23.45	-1.02**	-0.49	21.50*	1628	115	387
Not married							-0.93**	0.51	22.72	-0.32	0.22	20.80	1948	106	308
Presence of father/ household size															
No father, 1 in household							-1.27	0.59	23.63	0.25	0.27	20.87	119	8	26
No father, 2-3 in household							-1.92**	1.10	23.77	-0.69	1.61	21.18	623	31	98
No father, ≥ 4 in household							-0.92	0.78	22.63	-0.44	0.25	20.99	880	46	123
Yes father, 2-3 in household							-0.71	-1.08	22.78	-0.48	-0.82	20.96	1089	74	263
Yes father, ≥ 4 in household							-1.95**	-2.54**	23.76	-1.47**	-0.63	21.87	862	61	181
Education (y)															
< 12							-1.05**	0.22	22.89	0.87**	0.09	21.21	1992	135	293
12+							-1.46**	-1.98**	23.30	-0.63*	-0.68	21.19	1584	86	402
Income (dollars/100)															
< 3,000	1.48*	3.55**	71.18**				-0.94	1.92	22.93				565	22	69
3,000 - 6,999	-0.70	-0.86	73.13				-1.29	-0.74	23.32				1160	73	151
4,000 - 12,999	-0.07	-0.58	72.69				-1.00**	-0.67	22.70				922	67	280
13,000+	0.55	0.36	72.09				-1.11	-3.00	23.25				362	24	92
Missing	-0.16	-1.48	72.90				-2.48**	-1.28	23.94				567	35	103
AFDC/Food Stamps															
Nonparticipant							-1.07**	-1.28*	22.97	-0.77**	-1.18*	21.24	1873	148	502
AFDC							0.84	4.84	21.08	2.63	7.74	17.92**	121	1	17
Food Stamps							-2.35**	-0.13	24.24	-1.17*	1.27	21.73	1031	51	148
AFDC and Food Stamps							-0.23	1.60	21.75	0.40	3.19*	19.69	551	21	28
Medicaid															
No							-1.21**	-1.11*	22.95	-0.99**	-0.83	21.36	2781	159	523
Yes							-1.20**	0.20	23.59	0.20	1.62	20.56	795	62	272
Employment															
Not working							-1.27**	-0.52	23.39	-0.79**	0.10	21.36	2948	173	525
Working at T_1/not working at T_2							-0.58	-1.30	22.22	0.32	-0.72	20.21	306	32	86
Working at T_2							-1.67*	-1.70	23.73	-1.11	-1.73	21.24	322	16	84

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

[a]Control group means and differences for WIC groups. Significance refers to differences from control group means. Reference group underlined.

[b]Sample size from maternal weight change analyses; cell sizes for other maternal anthropometry are slightly smaller.

Peripheral skinfold thickness has been reported to change far less than truncal skinfolds over the last two trimesters of pregnancy (Taggart et al., 1967). The greatest increases are during the second trimester with stability or moderate decline in the third trimester and rapid postpartum decline. In this study, triceps skinfold thickness increased during the second trimester more than reported by Taggart.

The difference in the triceps skinfold between WIC enrollees and controls at followup was generally independent of maternal characteristics; even when differences between the two groups were small, they appeared to be a function of low control group values (the number of controls in some strata were very small and observed values therefore inherently unstable) rather than an increased thickness of WIC group skinfolds.

Triceps skinfold was smaller at followup given WIC benefits, independent of maternal weight or Quetelet's index (a measure of body mass; weight/height^2) at conception, ethnicity, education, Medicaid receipt, or income. Possibly effects were less among multiparae, heavy smokers, tallest women, and those receiving both Food Stamps and AFDC simultaneously. In general, however, the results are compatible with a relationship of WIC benefits to lower triceps skinfold that was independent of prior characteristics. Tables V-10 and V-11 and Volume IV, Appendix V-C-4 summarize these results.

While enrollment in the WIC program was associated with smaller triceps skinfold at followup relatively independent of prior maternal characteristics, this was not true of WIC/control differences in subscapular skinfold thickness at followup. Differences were concentrated among older, multiparous, heaviest, fattest, married, nonsmoking, and Medicaid recipient women. In general, control women with these characteristics had thick subscapular skinfolds, and such findings were not evident among WIC recipients. These results are summarized in Tables V-10 and V-11 and Appendix C-4.

Duration of WIC Benefits

The results of maternal anthropometry in relation to the duration of WIC benefits are reasonably straightforward (see Table V-12). First, there is no interaction between duration of WIC benefits and weight gain or change in arm circumference. (While there is change in weight during pregnancy, there appears to be no significant change in arm circumferences.) Second, there is a highly significant relationship between duration of WIC benefits and discrepancy from the control group for both triceps and subscapular skinfold thicknesses. (Among controls, subscapular skinfold did increase more rapidly than triceps skinfold, consistent with the observations of Taggart et al. [1967].) Third, differences were only minimal between the partially and fully adjusted regression analyses, suggesting that results did not arise because of bias from selective recruitment into the different study groups. Thus, the highly significant relationships between duration of WIC benefits and discrepancy in skinfold thickness support a conclusion that the relationship was causal.

Table V-11

Significant Differences[a] Among Control Women in Maternal Anthropometric Measurements at Followup, Associated with Maternal Characteristics[b]

Maternal characteristics	Weight (kg)	Arm circumference (cm)	Triceps skinfold (mm)	Subscapular skinfold (mm)	Sample size[c] (n)
Age (y)					
<18			23.46	20.90	59
18-19			22.22*	20.41	135
20-29			23.31	21.24	438
30+			23.72	22.88*	63
Past low birthweight					
Parity = 0					
Multiparal				20.68	315
No				21.72	313
Yes				21.32*	67
Weight at conception (kg)					
<50.35	71.61	24.78***	21.92	19.20*	171
50.35-63.49	72.73	27.46	22.58	20.46	312
>63.5	73.08	31.12***	24.57***	23.52***	212
Height (cm)					
<157.4			24.17*		151
157.4-162.6			23.10		261
162.7-167.5			22.85		135
>167.5			22.39		148
Quetelet's index at conception (kg × 100/cm^2)					
<.19		25.97*	21.81*	18.79***	134
0.19-0.27		27.44	23.01	21.10	447
>.27		32.32***	24.78**	23.93***	114
Cigarettes/day (n)					
0			23.84		426
1-5			22.77		63
6-14			22.42*		108
15+			21.24***		98

See footnotes at end of table. (continued)

Table V-11 (continued)

Maternal characteristics	Weight (kg)	Arm circumference (cm)	Triceps skinfold (mm)	Subscapular skinfold (mm)	Sample size[c] (n)
Ethnicity					
White non-Hispanics			22.64*		89
White Hispanics			23.90		146
Black			22.60		135
Other			22.69		25
Marital status					
Married				21.50*	308
Not married				20.80	387
Income (dollars/100)					
<3,000	71.18**				69
3,000-6,999	73.13				151
7,000-12,999	72.69				280
13,000+	72.09				92
Missing	72.90				103
AFDC/Food Stamps					
Nonparticipant			22.97	21.24	502
AFDC			21.08	17.92**	17
Food Stamps			24.24*	21.73	148
AFDC and Food Stamps			21.75	19.69	28

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Significance refers to differences from reference group (underlined).
[b]See Volume IV, Appendix V-C-1, for full covariate set.
[c]Sample size from maternal weight change analyses; cell sizes for other maternal anthropometry are slightly smaller.

Table V-12

Duration of WIC Benefits and Maternal Anthropometry Controlling for Maternal and Sociodemographic Characteristics at Registration[a] (Regression Coefficients)[b]

	Weight (kg) at f/u	Arm circumference (cm) at f/u	Triceps skinfold (mm) at f/u	Subscapular skinfold (mm) at f/u
Initial measurement	0.824***	0.094***	0.694***	0.701***
Duration of gestation at registration (d)	0.008	0.003	0.006	0.283*
WIC vs. controls	-1.321	-5.344	5.583	8.313*
WIC/control vs. controls	4.851	-2.625	20.132**	31.649***
WIC x T_1	0.007	0.026	-0.018	-0.039**
WIC/control x T_1	-0.020	0.011	-0.082**	-0.134***
Duration of participation (d)/(T_2 - T_1)	0.051***	0.008	0.027*	0.041***
WIC x (T_2 - T_1)	0.004	0.019	-0.040**	-0.038**
WIC/control x (T_2 - T_1)	-0.023	0.010	-0.095**	-0.134***
Sample size (n)				
WIC	3576	3655	3619	3579
WIC/control	221	255	225	223
Control	695	719	717	701

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]See Volume IV, Appendix V-C-1, for full set of covariates.

[b]Coefficient is difference from the control group mean.

If WIC benefits caused differential change in maternal anthropometric indices in pregnancy during program enrollment, it is logical that change might be greater the longer the woman participated in the program. In these linear multiple regression analyses, study status (i.e., WIC and WIC/control) was interacted with the length of time between initial assessment and followup. If these interaction terms are statistically significant, it implies that the longer the duration of WIC benefits, the greater the difference between WIC groups and controls and that duration of participation in the program was differentially related to program effects. Such significant relationships would be consistent with a causal relationship between WIC benefits and outcome.

Duration of time between visits among controls was significantly related to change in weight and to both skinfold thicknesses, but not to arm circumference. Weight change over time was not significantly different in either WIC group compared to controls. In other words, regression coefficients for the interaction between WIC status and duration were not statistically significant.

The interactions between duration of study participation for both skinfold measures and for both WIC study groups (initial WIC recruits and WIC/controls) were all highly significant. Thus, the discrepancy between controls and both WIC groups increased significantly with duration of study participation: both skinfolds became more discrepant from those of controls as time enrolled in the WIC program increased.

These results are reasonably strong evidence for a causal relationship between WIC benefits and less accelerated increase in skinfold thickness for both skinfold measures.

State WIC Directors' Assessment of Local WIC Program Effectiveness

The results of this analysis are presented in Table V-13. The 997 women enrolled in WIC programs in States from which program evaluations were not returned are different from those in States in which evaluations were returned (either the WIC/control women or the initial WIC sample). The women from the States with missing evaluations were heavier, had lower weight gains, had larger changes in arm circumference and subscapular skinfolds than others, and had the lowest decrement of change in triceps skinfold compared to controls. Of the six States for which evaluation data were not available, three were very large, with very large urban populations. It is likely that the anthropometric indices from women in these States reflect their social, ethnic, and demographic characteristics rather than WIC program effects. (Mean birthweights of their children were significantly low; see Section V.E for greater detail.)

The State WIC Directors' perception of program quality was related significantly only to less depressed change in triceps skinfold relative to controls. Whether this difference might have mediated the observed perinatal outcomes discussed in Section V.E is purely speculative.

Table V-13

State WIC Directors[a] Evaluation of WIC Program Quality and Maternal Anthropometry Adjusting for Selected Maternal Characteristics[b,c] (Regression Coefficients)

	Maternal anthropometric change			
	Weight (kg)	Arm circumference (cm)	Triceps skinfold (mm)	Subscapular skinfold (mm)
Mean, control group[d]	72.338	28.113	22.930	20.798
WIC/control[e] vs. controls	-.126	-.826	-.816	.072
WIC,[f] without rankings, vs controls	-.424*	.770**	-.393	.499*
WIC,[f] with rankings, vs controls	.193	-.517	-1.476***	-1.089***
Ranking (change per standard unit)	.034	-.156	.258*	.039
Control	593	613	611	601
WIC/control	179	182	182	180
WIC without ranking	979	997	981	959
WIC with ranking	1,841	1,878	1,869	1,860

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a] 135 programs evaluated by 22 State WIC Directors for 1,878 women with known perinatal outcome (no evaluation received from five states for 39 programs serving 997 women from our initial WIC sample, and with no evaluations for the 182 women initially recruited as controls who were enrolled in the WIC program by followup with known perinatal outcomes).

[b] Control group means and differences from means for WIC groups, adjusted for initial measurement.

[c] See Volume IV, Appendix V-C-1, for specification of all covariates.

[d] Controls at recruitment and followup.

[e] Controls at recruitment enrolled in WIC by followup.

[f] WIC at recruitment and followup.

Other Factors Associated with Maternal Anthropometry

Table V-9 presents significant associations between a variety of maternal characteristics and late pregnancy anthropometric measurements, adjusted for initial measurement. Therefore, this analysis is equivalent to an analysis of change in each measurement during study enrollment.

The major limitation in interpreting the meaning of regression coefficients is colinearity between independent variables simultaneously included in the analysis. A good example is the relationship of maternal cigarette smoking to change in subscapular skinfold thickness. In the model in which only mothers' smoking at initial interview is included there is a highly significant negative relationship between smoking and subscapular skinfold thickness at followup (0.05 mm less for each cigarette smoked, $p < 0.001$). On the other hand, in the model with smoking both at initial interview and at followup interview, highly colinear variables, the regression coefficient for each is nearly identical (0.03 mm decrease for each cigarette smoked per day at initial interview and 0.02 mm decrease for each cigarette smoked per day at followup). However, neither of these separate relationships is significant. The two variables are highly colinear, and the significance of their joint effect is not represented by the significance of either coefficient separately.

Some factors are consistently important for changes in all or the majority of maternal measurements. For instance, maternal weight at conception was highly significantly related to changes in all four indices (see Table V-9). The number of cigarettes smoked and being black (compared to being white) was consistently related negatively with changes in all measures. Indeed, these results are the first of which the authors are aware that suggest some specific mechanisms for the low birthweight of blacks and complement and extend past reports of both low pregnancy weight gain (Rush, 1974) and low plasma volume expansion (Pirani and MacGillivray, 1978) in smokers. Low birthweight in blacks has been only minimally explained by their social status or other measured factors. This lower than average increase in skinfold thickness during pregnancy may thus be an important nongenetic physiological mediator of what have been generally inexplicable group differences in fetal growth.

The magnitude of depression in weight gain with cigarette smoking (about 1 kg per pack of cigarettes smoked at recruitment) is lower than of past observations (Rush, 1974), but still highly significant. Mothers' height was associated positively with weight gain and negatively with change in arm circumference and subscapular skinfold thickness. In the model including potential mediating variables, there was a significant relationship between the reported caloric intake at initial interview and maternal weight gain ($p < 0.05$). Other maternal characteristics were not related consistently to changes in other anthropometric indices.

The fathers' education and whether fathers were currently employed were related to an increase in arm circumference. Medicaid receipt and maternal occupation in sales, skilled trade, or clerical work (vs. physical

labor, manufacturing, or service work) were positively related to changes in triceps skinfold; AFDC and number of past low-birthweight deliveries were negatively related to changes in triceps skinfold. Mothers' education was positively related and history of past stillbirth, family income, and fathers' never having worked (vs. physical labor, manufacturing, or service work) were negatively related to changes in subscapular skinfold thickness.

Thus, being black, smoking, and low initial weight emerge as consistent and strong determinants of poor performance among selected anthropometric indices during pregnancy. Other factors are less consistent and less clearcut.

These analyses are supplemented by aggregating all significant differences among control group women stratified by the several maternal risk factors used in the analyses of WIC effects (see Table V-11). These results, not surprisingly, are consistent with those using regression coefficients.

The factors associated with anthropometric status at study enrollment also were studied. Maternal weight at registration was strongly and significantly associated with maternal age, parity, height, education, with being Hispanic or black, and negatively to fathers' education, or fathers' being in sales, skilled, or professional occupations (compared to those in manufacturing, physical labor, or service occupations).

The factors relating to weight change between conception and initial visit were somewhat different. Maternal age was related only marginally to early pregnancy weight change, parity somewhat more so, height very strongly, history of past low-birthweight delivery much less so (but still highly significant), and maternal education only marginally. The relationship with ethnicity was reversed: while black and Hispanic women were heavier than control white women at initial interview, their weight gains from conception to study recruitment were less than those of whites, although not significantly so. Mothers' smoking was significantly related to lower weight at initial interview, but not significantly to weight gain to initial interview. Initial arm circumference was positively associated with reported beer intake ($p < 0.001$) (but not with other alcoholic intake), with the number of past low-birthweight infants ($p < 0.05$), and, not surprisingly, with maternal weight ($p < 0.001$). It was negatively associated with maternal height ($p < 0.001$). Aside from obvious relationships, such as with maternal weight, the set of covariates relating to initial triceps skinfold was somewhat different than the covariates relating to initial subscapular skinfold. Triceps skinfold thickness at registration was significantly and positively related to maternal parity, education, and receiving Medicaid and negatively to cigarette smoking, being black, and receiving AFDC. Initial subscapular skinfold thickness was negatively and significantly related to smoking and to the amount of time that work entailed standing; it was greater among women who did farm work, among Hispanic women, and among women who were currently employed.

Hematological Measures

Maternal Hemoglobin and WIC Benefits. Results are presented in Table V-14, and the full regression analysis on final hemoglobin level is presented in Volume IV, Appendix V-C-2. Data for initial and last prenatal hemoglobin or hematocrit were available for 1,449 women in the initial WIC group and for 478 initial controls. The mean initial hemoglobin level adjusted only for duration of gestation at measurement of the initial WIC sample was significantly lower than that of controls (0.13 g less per 100 ml, $p < 0.05$); but with adjustment for all covariates, this difference was only 0.01 g/100 ml (n.s.).

Change in hemoglobin level from the initial level was nearly identical among WIC women and controls in the partially adjusted analysis. With further adjustment, the increment was 0.06 g/100 ml (n.s.). Thus, there is no significant relationship of WIC benefits to either initial or final hemoglobin levels.

Maternal Risk Characteristics. Significant relationships between initial hemoglobin level and change in hemoglobin in the regression analyses, including the large array of maternal sociodemographic and reproductive characteristics, are summarized in Table V-14. Whites had significantly higher initial hemoglobin levels than women in other ethnic groups (blacks were lowest), and maternal age, education, and receipt of Food Stamps were associated with higher initial hemoglobin. Women working on farms, in sales, and in skilled trades had higher levels than those in manufacturing and service, and the unemployed had lower levels than housewives.

Change in hemoglobin levels between first and last prenatal measurements was significantly less in blacks than in whites and among those on Medicaid and higher with increased paternal education. Of the 1,170 women who reported taking iron supplements during pregnancy, hemoglobin levels were neither initially low nor significantly higher in late pregnancy (0.11 g/100 ml, $p = 0.10$).

4. Conclusions

There were two central reasons to relate change in maternal anthropometric indices and hemoglobin concentration to enrollment in the WIC program. The first was to assess whether WIC benefits were related to demonstrable maternal change, and the second was to assess whether maternal change might mediate fetal growth and well being.

There is overwhelming past evidence relating both maternal weight and weight gain to fetal growth (but much less, if any, on whether maternal energy stores deposited in adipose tissue and reflected by skinfold thickness have any independent relationship over and above weight or change in weight). There is also fairly consistent evidence that balanced calorie and protein nutritional supplementation during pregnancy can lead to modest increases in birthweight, typically in the range of 30 to 60 g. However,

Table V-14

Maternal Risk Characteristics and Earliest and Last Hemoglobin Concentrations During Pregnancy (Significant Coefficients from Multiple Regression Analyses[a])

Maternal risk characteristic	Units	Hemoglobin concentration (g/dl) in pregnancy: Earliest	Last
WIC at registration (vs. controls at registration)		.010 (p=.86)	.062 (p=.37)
Initial hemoglobin	(g/dl)	-	.481***
Duration of gestation at early measurement	(d)	-.009***	.002*
Duration of gestation at last measurement	(d)	-	.003***
Education	(y)	.028*	
Weight at conception	(kg)	.009***	
Parity	(n)		-.086*
White Hispanic (vs. white non-Hispanic)		-.234**	
Black (vs. white non-Hispanic)		-.728***	-.181**
Other ethnicity (vs. white non-Hispanic)		-.415**	
Household size	(n)	-.035**	
Food Stamps = 1, others = 0		.163**	
Medicaid = 1, others = 0			-.161*
Mother unemployed[b]		-.116*	
Hours on feet at work at study enrollment		.136*	
Mother farmworker[c]		.501*	
Mother sales worker[c]			
Father never worked[c]		-.137*	-.176*
Fathers education	(y)		.036*
Date of first prenatal visit missing vs. not missing		-.528**	-.433*

*p < 0.05.
**p < 0.01.
***p < 0.001.
- = not applicable

[a]See Volume IV, Appendix V-C-1, for full covariate list.

[b]Versus housewife, student, disabled.

[c]Versus physical labor, service, manufacturing.

it is not at all clear that programs of maternal nutritional supplementation can affect maternal weight gain or that the effects of supplementation on birthweight are mediated by weight gain. (For further discussion of relationships of maternal weight and weight gain to birthweight and of the relationship between maternal nutritional supplementation and fetal growth, see Rush, Davis, and Susser [1972] and Rush [1982].) Thus, the present study may be important not only in the evaluation of the WIC program, but also may add to the basic understanding of the relationships between maternal nutrition and maternal and fetal health.

Women recruited into the WIC program were slightly heavier at conception than control women but gained significantly less weight from conception to initial interview (their weight at initial interview, controlled for weight at conception, was significantly lower than that of controls). From study recruitment to followup in late pregnancy, their weight gains were nearly identical to that of controls. Thus, significant early disparity in weight gain was reversed during WIC program enrollment. This is interpreted as a beneficial program effect.

Women enrolled in the WIC program had less increase in triceps and subscapular skinfold thicknesses than controls, and the causal nature of these relationships is made more likely by the significant relationship of differences between WIC and control women with duration of enrollment in the WIC program. It appears unlikely (but not impossible) that these observations could have been due to biased reporting: field operatives would have had to measure systematically the skinfolds of women enrolled in the WIC program lower than those of controls, but only at reinterview in late pregnancy and not at initial measurement.

Given that the evidence is strong that the observed differences were real and that they were caused by WIC program enrollment, it is important to consider whether such differences were beneficial. The authors are unaware of any precedent from past research that helps to answer this question: while increased fat deposition through the second trimester (at least, truncal fat) is a normal maternal physiologic response to pregnancy, as is weight gain or plasma volume expansion, the observed WIC program effect is more complex: sustained weight gain, equivalent to that of controls, with lower late pregnancy fat stores. The most likely sequence of events would appear to be a balanced increase of nutritional intake followed by greater use of ingested and stored energy for the metabolic needs of pregnancy. Given that reduced late pregnancy fat stores also were associated with cigarette smoking and among groups with frequent adverse pregnancy outcome, such as black women, it is not possible to conclude that reduced late pregnancy fat storage is in itself a good thing. Rather, the implications of how large the fat stores are and how fast and to what extent they are changing, whether increasing or diminishing, are probably contingent on a set of complex interrelationships among maternal diet, activity, basal needs, initial weight and fat stores, and other factors, both extrinsic or environmental (e.g., smoking or work patterns) and intrinsic (e.g., ethnicity and age). This means that a simple approach to the skinfold (e.g., "bigger [or smaller] is better") does not conform with

the likely true complexity of the relationship between fat stores and pregnancy outcome. It does seem that one cross-sectional measure, rather than serial measures, taken without concurrent evaluation of other nutritional indices, is almost surely going to be confusing and perhaps misleading.

In summary, our tentative conclusion is that the pattern of maternal anthropometric change associated with WIC participation (i.e., acceleration and normalization of depressed early pregnancy weight gain and less accelerated fat storage in mid to late pregnancy) was a pattern likely to have been advantageous to the fetus. Certainly, it would likely help the mother to be able to return more easily to her basal prepregnant weight following delivery.

Women who entered the WIC program had significantly lower hemoglobin concentrations than controls, but this difference was totally accounted for by adjustment for sociodemographic and health disparities across study group. WIC program enrollment had no demonstrable effect on hemoglobin concentration, but there also was no relationship of hemoglobin concentration to the much greater amounts of iron in dietary supplements. Both of these results could follow from very inaccurate measurement. That is, real differences might have been obscured by imprecise hemoglobin measurement. This possibility, however, is not consistent with the significant relationship of hemoglobin concentration to many other maternal characteristics, although not to WIC program participation or iron supplementation. The lack of relationship of hemoglobin concentration to iron intake is consistent with past experience of little or no response of maternal hemoglobin concentration to iron supplements (Hemminki and Starfield, 1978).

Hemoglobin concentration in pregnancy is clearly not a good index of the adequacy of maternal iron intake, and any serious attempt to ascertain the effects of the WIC program, a change in diet in general, or iron supplements on iron metabolism in pregnancy requires measurement of several concurrent hematologic indices. It would probably be best not to pursue any further hematologic studies in pregnancy limited to measuring hemoglobin concentration, since such studies may give a false sense that something valuable and serious may be learned when that is almost certainly not true.

D. HEALTH CARE INDICES

1. Introduction

In this section, enrollment in the WIC program is related to changes in several indices not directly related to the provision of supplemental food but that may have been affected by counseling that is provided by the WIC program, and further, may have mediated effects of the WIC program on perinatal outcome. These are:

- The frequency of prenatal visits between initial registration into the study and followup.

- Change in the number of hours worked each week between study recruitment and followup.

- Change in the number of cigarettes smoked from study recruitment to followup.

- Change in the reported intake of alcohol between study recruitment and followup.

Later in the chapter WIC program enrollment and several indicators of WIC program quality are related to plans to breastfeed and to the actual rate of breastfeeding before hospital discharge.

2. Analytic Methods

In each analysis the mean value for women who were initially recruited into the control group and who remained controls is contrasted with that of women who were initially enrolled into the WIC sample and with that of the small group of control women who subsequently enrolled in the WIC program between initial study visit and followup (WIC/controls).

There are four linear multiple regression analyses for each outcome. The first analysis is of the initial level of the variable at registration into the study controlled only for the duration of gestation at registration into the study; the second also is for the initial level at study registration, but adjusted for a large set of additional maternal health and sociodemographic characteristics (see Volume IV, Appendix V-D-1, for a full listing of the covariates). The third is for the level at followup visit controlled for the initial value (and therefore equivalent to change in the index from initial visit to followup) and duration of gestation at initial visit and followup; the fourth is for the level at followup adjusted for the same covariates describing maternal characteristics at registration into the study as those in the second analysis, above. The regression analyses for alcohol and tobacco are presented as Appendix V-D-2.

The linear multiple regression models used for the analyses of breastfeeding and WIC program enrollment were somewhat different from those in the other analyses: it was not hypothesized that WIC program enrollment early in pregnancy would be more important than exposure to the program later in pregnancy. Plans to breastfeed and actual breastfeeding were contrasted in two different ways: first, the rates for all initial WIC recruits were compared to all initial controls, and then for all women who were ever enrolled in the WIC program during this pregnancy vs. those who were never enrolled. Since the information on who entered the WIC program after recruitment was gained from interview at late pregnancy revisit, some of the women in the control group but without late pregnancy evaluation either had been in the WIC program or would have been had they not delivered prematurely. The contrast between initial WIC and initial control groups is therefore somewhat more secure methodologically. The study was limited to women enrolled in the study before the 28th week of pregnancy.

The unadjusted differences between WIC and control groups are contrasted with the differences adjusted for several sociodemographic and health characteristics of the mother; in addition, plans to breastfeed were further adjusted for several possible mediating variables: the frequency of nutrition education sessions, who gave the sessions, whether the mother felt that such advice had affected her own dietary patterns during pregnancy, whether infant feeding advice was given, and from whom and what type of feeding was recommended. Actual rates of breastfeeding were adjusted for whether the hospital distributed free formula samples (29 percent of hospitals did so) in addition to maternal health and sociodemographic characteristics. However, it is important to remember that the outcome under study is breastfeeding while still in the hospital; the free formula would have been donated upon discharge.

Unless otherwise stated, results referred to in the text are for analyses adjusted for the larger set of maternal characteristics.

3. Results

Frequency of Early Enrollment and Visits for Prenatal Care

The Longitudinal Study did not provide a meaningful test of whether WIC induces pregnant women to enter prenatal care earlier in pregnancy. The method of recruiting women for the control group assured that they had entered prenatal care by their sixth month of pregnancy. Thus the control group contained an artificially high proportion of women who had entered prenatal care early. That artifact made comparison with WIC women's early enrollment uninterpretable.

Women recruited into the WIC sample had significantly more prenatal visits at the time of the first interview than controls. That also was an artifact of the method of recruitment into the study. Women in the WIC sample had to have come to the WIC clinic for the first time, but they may have had some prenatal care, while controls were recruited only if they had received no previous prenatal care during that pregnancy. The greater number of prenatal visits for WIC women at the time of the initial interview was not diminished when adjustment was made for the larger set of covariates.

It was possible to test whether WIC women had more prenatal care visits than controls between the initial and followup interviews. On these tests there were no statistically significant differences between either group of WIC participants and controls. Therefore there is no evidence that enrollment in the WIC Program is related to frequency of prenatal care in this study population, once the woman has registered for care.

Change in Hours Worked Each Week

The economic benefits of the WIC program might lead to a reduction in the time women worked. The mean amount of time worked by women employed, either part-time or full-time, at initial visit (n = 692) was 28.2 hours

per week; by followup, this had fallen to 12.3 hours per week. Differences were not significant, but women in the WIC sample worked 0.6 fewer hours each week at registration into the study than controls; WIC/controls worked [illegible].9 fewer hours. (The analyses omitted the highly colinear variables describing maternal employment and AFDC.) Results are summarized in Table V-15.

At followup, there were no significant differences between WIC recipients and controls in the number of hours worked. There is no evidence from these data that the economic benefit of the WIC program was used by mothers to reduce the time worked. These results are not consistent with WIC benefits being used as an income transfer, at least to reduce the work in late pregnancy.

Cigarette Smoking

As reported in Table V-16, at registration into the study, women enrolled in the initial WIC sample were smoking significantly fewer cigarettes daily than were residual controls (0.62 fewer cigarettes per day, $p < 0.05$). At followup, women in the WIC group had increased their

Table V-15

Differences Between the Control Group and Women Enrolled in the WIC Program for the Number of Hours Worked per Week Among Those Reporting Work at Initial Interview[a,b]

		Controls at registration	
Number of hours worked per week	WIC at registration	WIC at followup	Controls at followup
Initial			
Partially adjusted	-0.484	-1.906	28.713
Fully adjusted	-0.639	-2.910	28.890
Followup			
Partially adjusted	-0.634	-4.317	13.000
Fully adjusted	0.422	-3.860	12.198
n	509	44	143

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Control group means and differences for WIC groups. Significance refers to difference from control group means.

[b]See Volume IV, Appendix V-D-1, for full covariate list.

Table V-16

Differences Between the Control Group and Women Enrolled in the WIC Program for Selected Prenatal Behaviors[a,b]

		Controls at registration	
	WIC at registration	WIC at followup	Controls at followup
Number of prenatal care visits			
Initial			
Partially adjusted	1.641***	0.166	0.151
Fully adjusted	1.779***	0.257*	0.038
Followup			
Partially adjusted	-0.215	-0.228	7.159
Fully adjusted	-0.062	-0.141	7.033
n	3,725	230	729
Number of hours worked per week			
Initial			
Partially adjusted	-1.783***	-1.139	5.891
Fully adjusted	-0.215	-0.792*	4.626
Followup			
Partially adjusted	0.099	-0.820	2.295
Fully adjusted	0.334	-0.595	2.096
n	3,700	231	719
Number of cigarettes smoked per day			
Initial			
Partially adjusted	-0.744**	-0.761	4.759
Fully adjusted	-0.624*	-0.233	4.638
Followup			
Partially adjusted	0.196	-0.059	4.056
Fully adjusted	0.099	-0.014	4.131
n	3,694	229	724
Number of ounces of ethanol consumed per week			
Initial			
Partially adjusted	-0.040	-0.034	0.206
Fully adjusted	-0.094	-0.048	0.249
Followup			
Partially adjusted	0.032	0.024	0.061
Fully adjusted	0.024	0.023	0.068
n	3,723	230	728

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Control group means and differences for WIC groups. Significance refers to difference from control group means.

[b]See Volume IV, Appendix V-D-1, for full covariate list.

smoking slightly more than controls (0.10 cigarettes per day, n.s.). The WIC program thus had no effect on the number of cigarettes smoked. This may be an issue for possible program attention.

Alcohol Intake

The initial WIC sample reported consuming significantly less alcohol than controls (0.094 fewer ounces per week, $p < 0.05$). At followup visit, there was a slightly, but not significantly, greater intake of alcohol among women in the WIC program compared to residual controls. Thus, as with cigarette smoking, there appears to be no detectable beneficial effect of intervention by the WIC program on intake of alcohol. These results are summarized in Table V-15.

Breastfeeding and WIC Program Enrollment

Results in this section (see Table V-17) relate WIC program enrollment to whether women planned to breastfeed when questioned at late pregnancy evaluation, and whether they actually attempted breastfeeding which was abstracted from the review of the hospital delivery and newborn records.

Ten and three-tenths percent fewer mothers in the initial WIC group and 12.7 percent fewer in the ever WIC group planned to breastfeed compared to their control groups ($p < 0.001$, and $p < 0.001$, respectively, see Table V-17). After control for sociodemographic differences between WIC and control women, the differences fell to 3.0 percent (n.s.), and 5.1 percent (n.s.), respectively. Thus, the largest part of the differences between WIC and control women could be attributed to sociodemographic differences. When further adjusted for possible mediating factors, these estimated differences were changed only slightly (to 3.2 and 7.0 percent, respectively). These small differences in estimated effects (0.2 percent and 1.9 percent) may be considered the extent of the effect of the WIC program that was mediated by these factors in the WIC group.

These are cross-sectional measures and therefore do not assess the effect of the program on changes in plans to breastfeed. Further, the estimates of differences in plans to breastfeed between women enrolled in WIC and control women were strongly affected by adjustment for sociodemographic differences (unlike estimates, for instance, of dietary intake). Thus, these differences between WIC and control groups most likely arise not from program effects, but from inherent differences in the two populations. These results cannot be interpreted as evidence of program effect, either beneficial or adverse.

The question of whether a woman breastfed was completed on only 2,250 of 4,921 hospital record abstracts, and 1,331 (59.2 percent) of these women were reported to have initiated breastfeeding. This rate is obviously high and probably means that the question was left blank for many women who chose to use formula. This analysis is limited to the 2,250 women for whom the question was completed (see Table V-17).

Table V-17

Estimates of Women Planning to Breastfeed at Followup Visit and Women Breastfeeding Upon Hospital Discharge

	WIC status			
	At registration into study		At followup visit	
	WIC[a]	Control[b]	WIC[c]	Control[d]
% Planning to breastfeed				
Unadjusted	-10.31***	65.09	-12.66***	66.94
Adjusted	-2.97	59.33	-5.13	61.03
n	1,391	381	1,482	290
% Breastfeeding				
Unadjusted	-5.23*	63.31	-7.16*	65.14
Adjusted	-0.29	59.38	-2.29	61.07
n	1,784	466	1,880	370

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Initial interview unadjusted.

[b]Initial interview adjusted for other maternal characteristics. Control group means and differences for WIC groups. Significance refers to differences from control group means.

[c]Followup interview and at hospital discharge, unadjusted.

[d]Followup interview and at hospital discharge, adjusted for maternal characteristics at registration into study. See Volume IV, Appendix V-D-1, for full covariate list.

Five and two-tenths percent fewer women in the initial WIC group ($p < 0.05$) and 7.2 percent fewer in the WIC at followup group ($p < 0.01$) breastfed, compared to their relevant control groups. With adjustment for maternal sociodemographic differences, these differences fell to -0.3 percent and -2.3 percent, neither significant. Thus, disparities between WIC and control women were almost entirely attributable to identifiable sociodemographic differences between them. It is impossible to conclude whether WIC program enrollment affected the rate of breastfeeding. It would be of great importance to know how many women sustained breastfeeding after discharge from hospitals and for how long. Such information would require followup after hospital discharge, which was not done in this study.

Table V-18

Proportion of Women Receiving Nutrition Education Sessions and Proportion of Women Reporting that Nutrition Advice Affected Eating[a]

Proportion (%) receiving 0, 1, 2, or 3+ nutrition education sessions

Number of nutrition education sessions	WIC at registration	WIC status: Control at registration — WIC at followup	WIC status: Control at registration — Control at followup	p≤[b]
0	13.0	17.5	41.9	0.001
1	31.3	31.6	28.4	NS
2	24.7	22.2	11.2	0.001
3+	30.4	28.2	17.8	0.001
Missing	0.5	0.4	0.8	NS
n	3,774	234	743	

Proportion (%) reporting nutrition advice was effective[c]

"Has nutrition education affected eating during pregnancy?"	WIC at registration	WIC status: Control at registration — WIC at followup	WIC status: Control at registration — Control at followup
Yes	66.0	61.1	61.6
No	34.0	38.9	38.4
n	3,258	193	430

[a] WIC = WIC at registration, WIC at followup
WIC/control = Control at registration, WIC at followup
Control = Control at registration, control at followup.

[b] Significance tested by chi square.

[c] Only for those who reported that they received nutrition education.

Frequency of Nutrition Counseling

The number of nutrition counseling sessions reported by women at followup visit, by WIC status, is presented in Table V-18. Many fewer women in the WIC program than controls had no nutrition education sessions (13.0 percent for WIC women vs. 41.9 percent for controls, $p < 0.001$), while many more WIC women had two or more nutrition education sessions (55.1 percent for WIC women vs. 29 percent for controls, $p < 0.001$).

WIC Program Effectiveness and Changes in Selected Maternal Behaviors

The State WIC Directors' estimates of WIC program quality were applied to the indices of maternal health care behavior (see Table V-19). These

Table V-17

Estimates of Women Planning to Breastfeed at Followup Visit and Women Breastfeeding Upon Hospital Discharge

	WIC status			
	At registration into study		At followup visit	
	WIC[a]	Control[b]	WIC[c]	Control[d]
% Planning to breastfeed				
Unadjusted	-10.31***	65.09	-12.66***	66.94
Adjusted	-2.97	59.33	-5.13	61.03
n	1,391	381	1,482	290
% Breastfeeding				
Unadjusted	-5.23*	63.31	-7.16*	65.14
Adjusted	-0.29	59.38	-2.29	61.07
n	1,784	466	1,880	370

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Initial interview unadjusted.

[b]Initial interview adjusted for other maternal characteristics. Control group means and differences for WIC groups. Significance refers to differences from control group means.

[c]Followup interview and at hospital discharge, unadjusted.

[d]Followup interview and at hospital discharge, adjusted for maternal characteristics at registration into study. See Volume IV, Appendix V-D-1, for full covariate list.

Five and two-tenths percent fewer women in the initial WIC group ($p < 0.05$) and 7.2 percent fewer in the WIC at followup group ($p < 0.01$) breastfed, compared to their relevant control groups. With adjustment for maternal sociodemographic differences, these differences fell to -0.3 percent and -2.3 percent, neither significant. Thus, disparities between WIC and control women were almost entirely attributable to identifiable sociodemographic differences between them. It is impossible to conclude whether WIC program enrollment affected the rate of breastfeeding. It would be of great importance to know how many women sustained breastfeeding after discharge from hospitals and for how long. Such information would require followup after hospital discharge, which was not done in this study.

Clinic Emphasis on Smoking, Alcohol Intake, Breastfeeding, WIC Enrollment, and Outcome

Clinic administrators for both WIC and control clinics were asked whether, and to what extent, reduction in smoking and alcohol intake and the importance of breastfeeding were emphasized in patient counseling (on a four-point scale, where 1 = no emphasis, 2 = little emphasis, 3 = some emphasis, and 4 = much emphasis). The average emphasis across all clinics was very high for all three issues: 3.3 for smoking, 3.6 for alcohol, and 3.8 for breastfeeding. These judgments of clinic administrators (as a continuous variable on the four-point scale) were related to change in tobacco and alcohol use in pregnancy, to rates of breastfeeding (see Table V-20), and also to whether the emphasis had differential relationships in WIC and control clinics.

There were no significant relationships between emphasis during patient counseling on reducing smoking or alcohol intake in the control clinics and actual change in use of tobacco and alcohol. In fact, higher levels of use of tobacco were partially associated with greater emphasis in the clinic. Further, there was no significant difference in reported

Table V-20

Change in Cigarette Smoking, Alcohol Consumption, and Proportion Breastfeeding by Clinic Emphasis and WIC Status

Change with one point change in four point rating scale[a]	Change in cigarette smoking (number/day) at followup	Change in alcohol consumption (oz. ethanol/week at followup	% Breast-feeding
Controls	0.068	-0.026	-2.717
WIC/controls	0.288	0.01	
WIC	0.072	0.001	-23.343***
Sample size (n)			
Controls	724	728	466
WIC/controls	229	230	--
WIC	3924	3723	1784

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]The scale was: no emphasis = 1
little emphasis = 2
some emphasis = 3
much emphasis = 4

Table V-19

State WIC Directors' Evaluation of WIC Program Quality and Maternal Health Outcomes[a,b,c]

	Prenatal visits (number)	Cigarette smoking (number/day)	Alcohol consumption (oz. ethanol/ week)
Mean, control group[d]	7.012	4.155	0.075
WIC/control[e] vs. controls	-0.140	-0.017	0.023
WIC[f] without rank vs. controls	0.062	0.025	-0.007
WIC with rank vs. controls	-0.084	0.092	0.026
Rank (change per standard unit)	0.055 (p=0.33)	0.116 (p=0.17)	-0.052 (p=0.54)
Sample size (n)			
Controls	729	724	728
WIC/controls	230	229	230
WIC without rank	1,256	1,241	1,254
WIC with rank	2,469	2,453	2,469

[a] 135 programs evaluated by 22 State WIC Directors for 2,469 women with known number of prenatal visits at followup (no evaluation received from five states for 39 programs serving 1,256 women with known number of prenatal visits at followup and with no evaluations for the 230 women initially recruited as controls who were enrolled in the WIC Program by followup).

[b] Values are differences from the control group means.

[c] Regression coefficients from linear multiple regression analyses adjusted for a wide variety of maternal characteristics (see Volume IV, Appendix V-D-1, for full set of covariates).

[d] Control at recruitment and followup.

[e] Control at recruitment, enrolled in WIC by followup.

[f] WIC at recruitment and followup.

perceptions of local program quality were not significantly related to frequency of prenatal visits or to change in alcohol or tobacco use, and, unlike the results for perinatal outcome or for maternal anthropometry, results for women in States for which we did not receive evaluations were indistinguishable from those of States with program evaluations. It appears that the quality WIC programs as judged by State WIC Directors, had little, if any, relationship to these health behaviors.

Table V-21

Percentage Experiencing Barriers to the Use of Health Care, Asked at Followup, by WIC Status[a]

Barriers to prenatal care	WIC at registration	Controls at Registration: WIC at followup	Controls at Registration: Controls at followup
Difficult to get appointment to see medical doctor	6.2	6.5	5.4
Difficult to get to place of medical care when open	16.6*	13.9	13.1
Getting to and from place of medical care a problem	21.4	18.6	20.4
Child care arrangements during medical care visit a problem	19.5*	20.5	24.9
(n)	(2171)	(127)	(397)
Transportation costs to and from place of medical care a problem	27.8**	27.8	22.6
Difficulties in paying for prenatal care	26.1**	20.9	20.2
(n)	(2994)	(206)	(600)
On Medicaid	45.7***	41.3	31.0
Private health insurance (Blue Cross/Blue Shield, etc.)	14.0	9.7	12.2
Medical care at reduced cost	30.0***	53.0	56.6
Sample size (n)[b]	3649-3941	202-260	655-780

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]This table is a descriptive cross-tabulation, and the data are not adjusted for maternal covariates.

[b]These sample sizes are usually appropriate. The sample sizes for exceptions are shown in parentheses in the specific cell.

Table V-22

Factors Significantly Related to Maternal Health Care Behavior at Registration into the Study and at Followup (Regression Coefficients from Multiple Regression Analyses)[a]

Regression coefficient	Units	Prenatal care visits (n) Regis-tration	Prenatal care visits (n) Followup	Smoking/day (n) Regis-tration	Smoking/day (n) Followup	Alcohol/week (oz) Regis-tration	Alcohol/week (oz) Followup	Percent planning to breast feed Followup	Percent breast-feeding Hospital
Characteristics at onset of study:									
Initial WIC sample, vs. controls		1.78***		-0.62*		-0.09*			
Initial controls, later WIC, vs. controls		0.26*							
Duration of gestation at registration	(d)	0.02***	0.03***	0.01***	-0.01**				
Duration of gestation at followup	(d)	-	0.05***	-		-			
Age	(y)	0.01*		0.11***		0.01*	0.01***		
Mother married (yes = 1)				-1.04**		-0.13**	-0.05*		
White Hispanic, vs. white non-Hispanic			-0.29*	-5.69***	-1.32***	-0.10*			
Black, vs. white non-Hispanic		-0.41***	-0.22*	-4.35***	-0.82***	0.12***		-26.87***	-24.69***
Other ethnic group, vs. white non-Hispanic				-4.17***					
Income missing	($/100)	-0.24***		-0.87**					
AFDC									6.63*
Medicaid		0.28***	0.35**		0.34*				-5.32*
Food Stamps				.72**			.06***		
Mother's education	(y)	0.03**		-0.33***	-0.10**			2.09**	1.45*
Mother employed, vs. housewife, student, disabled						0.10*			
Mother unemployed, vs. housewife, student, disabled				1.09***		0.12**	0.07***		
Mother farmworker[b]						.40***			
Mother sales worker, skilled trade[b]		0.16**							
Mother professional[b]		.31*							11.24*
Mother never worked[b]				-0.93***				-7.30*	-8.50**
Father farmworker[b]									13.26**
Father never worked[b]		0.20**							
Father employed, vs. unemployed		-0.13*						-5.75*	

See footnote at end of table.

(continued)

Table V-22 (continued)

Regression coefficient	Units	Prenatal care visits (n) Registration	Prenatal care visits (n) Followup	Smoking/day (n) Registration	Smoking/day (n) Followup	Alcohol/week (oz) Registration	Alcohol/week (oz) Followup	Percent planning to breastfeed Followup	Percent breast-feeding Hospital
Father retired, in jail, disabled, vs. unemployed		-0.26***						-10.22*	-10.81**
Prenatal care visits at registration	(n)	-		-0.25***					
Father living in household (yes=1)						.11*			
Cigarettes/day at registration	(n)			-	.84***				
Alcohol/week at registration	(oz)					-	.14***		
Cesarean section		-	-	-	-	-	-	-	-7.47**
Changes during study participation:									
Breastfeeding recommended, vs. bottle feeding		-		-		-		13.13***	
Both breastfeeding and bottle feeding recommended vs. bottle feeding		-		-		-		-31.41**	
Other feeding method recommended vs. bottle feeding		-		-		-		-23.08*	
Nutrition education given by WIC staff, vs. others		-		-		-		6.19*	
Nutrition education given by non-WIC health staff, vs. others		-		-		-		14.11***	
Nutrition education given by other source, vs. all others		-		-		-		7.39*	
Mother's diet affected by nutrition education, vs. not affected		-		-		-		-5.6**	
n WIC		3,726		3,695		3,724		1,391	1,784
n WIC/control		230		229		230		91	96
n Control		731		726		730		290	370

*p < 0.05.
**p < 0.01.
***p < 0.001.
- = not applicable.

[a]Adjusted for maternal risk characteristics at registration into study and changes during study participation. See Volume IV, Appendix V-D-1, for full covariate list including changes during study participation. Regression coefficients for changes during study from supplemental regression analysis in which these factors were included in addition to maternal characteristics at registration.

[b]Versus physical labor, service, manufacturing.

Thus, early prenatal care was associated with a variety of social and educational characteristics with, in general, better educated, older, and more privileged women. The frequency of early and continuing prenatal care was positively associated with government financing of health care (Medicaid).

Cigarette Smoking. The amount of smoking at initial visit was related significantly to maternal age, receipt of Food Stamps, white ethnicity, being unmarried, and fewer years of education, and negatively to never having worked (vs. manufacturing/labor/service). Increased smoking between study enrollment and followup visit was associated negatively with maternal education and with either black or Hispanic ethnicity (compared to whites). These results are consistent with past reports that smoking is low in blacks and that both smoking and the amount inhaled in pregnancy are strongly and negatively associated with maternal education and social status.

Alcohol Intake. Alcohol intake at initial interview was significantly associated with maternal age, being unmarried, living with the father of the infant (these last two variables are highly negatively correlated and should be interpreted cautiously), working on a farm (vs. manufacturing/service), and black ethnicity (vs. whites). Hispanics drank significantly less than whites.

Increased alcohol intake from initial visit to followup was significantly associated only with maternal age, mother being employed (vs. housewife/student/disabled), and receipt of Food Stamps.

Plans to Breastfeed at Followup Visit. Of factors assessed at initial interview only years of maternal education ($p < 0.01$) were significantly related to plans to breastfeed. There were significant negative associations with black ethnicity ($p < 0.001$), never having worked, and father either employed or in military service/retired/disabled (vs. father unemployed).

Among factors relating to intervention between initial visit and followup, counseling to breastfeed, particularly from health care personnel (presumably, doctors and nurses), was significantly related to plans to breastfeed. There was a strong negative relationship if other or mixed methods of feeding had been counseled and also if the woman stated she had changed her own diet on the basis of dietary advice.

Rate of Breastfeeding in Hospital. The following factors were related to breastfeeding (from hospital record abstraction): maternal education, professional occupation, receipt of AFDC, and father a farm worker. Black ethnicity (vs. whites), mother never having worked, receipt of Medicaid, being unemployed at initial visit, and delivery by cesarean section were significantly negatively related to breastfeeding.

4. Conclusions

In these exploratory analyses, no associations were found between enrollment in the WIC program and several indices that might affect perinatal outcome:. frequency of prenatal visits, hours of work each week, use of tobacco, or use of alcohol. There was no regular or coherent relationship of WIC program enrollment with plans to breastfeed or with the initiation of breastfeeding before hospital discharge.

E. PREGNANCY OUTCOME

1. Introduction

This section presents findings that describe the relationship between WIC program enrollment and duration of gestation, newborn size, and fetal mortality, in the total study population and within subgroups of women defined by different risk characteristics. The effects of duration of WIC program enrollment on outcome measures are estimated, and the quality of each local WIC program, evaluated by State WIC Administrators, is related to selected outcome measures. Finally, maternal characteristics other than WIC program enrollment are related to perinatal outcome.

Analyses were limited to singleton births and to women who entered the study before the 196th day of gestation (28 weeks). Late in the field study, an original study criterion that no women be recruited past 196 days of gestation was relaxed. Thus, from the data collected from that time forward, there was an estimate of the frequency of late pregnancy enrollment; but women enrolled in the third trimester of gestation were excluded from the estimates of the effect of the WIC program on perinatal outcome for several reasons. First, few such women were recruited into the study and, of those who were recruited, the proportion of WIC recipients compared to control women was larger than in the rest of the study population. Even with statistical adjustment, the results of the study would be distorted by these differences in the proportion of late recruits, relative to the rest of the study population. Second, and more importantly, with only limited duration of WIC benefits, the experience of these women is not a fair test of program effectiveness. Such women could not be included in analyses used to judge the frequency of preterm delivery, and their numbers were too small to test adequately for differential effects of short and long exposure to program benefits. Further, they were not reevaluated a second time in pregnancy, and change in maternal status could neither be evaluated nor related to perinatal outcome.

A WIC program effect on birthweight of some 30 to 50 grams was hypothesized for those recruited by mid-pregnancy, mediated both by increased duration of gestation and by accelerated fetal growth. Intuitively, one might expect the entire effect of nutritional supplementation to be on accelerated fetal growth. In fact, past work on nutritional supplementation in pregnancy strongly suggests that a large part of the observed effect on birthweight, at least in studies among women not experiencing starvation or extreme deprivation, is attributable to longer duration of gestation.

2. Analytic Methods

WIC Program Participation

The analytic strategy is parallel to that used throughout this study. (See Volume IV, Appendixes V-E-1 and V-E-2.) For all indices of pregnancy outcome (e.g., duration of gestation, birthweight, infant length and head circumference, and fetal death) the central analyses compare outcome between all women bearing singleton infants carrying to at least 20 weeks gestation and initially recruited into the WIC sample (for the analysis of birthweight, n = 3,021) with all similar women initially recruited as controls, whether or not they later enrolled in the WIC program (for birthweight, n = 869).

In the control group, approximately one-quarter of the women for whom there is information at late pregnancy followup reported that they had subsequently enrolled in the WIC program between recruitment and followup. The reason they were not excluded from these analyses is that for the key group of women without late pregnancy followup information (n = 313 in the WIC group, and n = 96 in the control group in the birthweight analysis), perinatal outcome was, not surprisingly, much worse than among those with a followup interview. Women without a followup interview had much shorter duration of gestation and a consequent higher rate of fetal loss than those for whom late pregnancy information was available. To have removed control women with followup information who were known to have entered the WIC program, while not being able to remove those who either delivered too early to join the program or who had joined the program but for whom such information was not available, would have distorted the results of the study and could have biased the results by overrepresenting women with adverse outcomes in the control group. The price paid to reduce such bias is that observed differences between all initial WIC recruits and all initial controls tend to underestimate the effect of the WIC program, since as many as one-quarter of control women probably had some WIC program benefits of uncertain duration.

In Appendix V-E-3, perinatal outcomes are presented separately for women according to whether followup was available and whether women in the control group later enrolled in the WIC program.

The five subgroups of women for whom results are presented in Appendix V-E-3 are:

- Women recruited into the WIC sample who returned for late pregnancy followup (in the birthweight analysis, n = 2,708).
- Women recruited into the WIC sample who did not return for late pregnancy followup (in the birthweight analysis, n = 313).
- Women recruited as controls who returned for late pregnancy followup and had, between recruitment and followup, entered the WIC program (in the birthweight analysis, n = 180).

- Women recruited as controls who returned for late pregnancy followup and had not been recruited into the WIC program (in the birthweight analysis, n = 593).

- Women recruited as controls who did not return for late pregnancy followup (in the birthweight analysis, n = 96).

Outcome is first adjusted only for maternal ethnicity and duration of gestation at initial maternal interview and then further adjusted for an array of other maternal and familial characteristics at the time of registration into the study. Newborn somatic growth is analyzed both with and without adjustment for duration of gestation, to differentiate effects of the WIC program on rate of fetal growth, vs. that on duration of growth.

WIC Benefits and Maternal Risk Characteristics

For women who returned for late pregnancy followup, analyses are presented including changes in maternal characteristics or behavior after registration to judge whether effects of the WIC program may have been mediated by these factors as well as to see whether change in these factors had effects on outcome. Specimen regression analyses for birthweight and head circumference are presented as Volume IV, Appendix V-E-2.

Duration of WIC Benefits

The estimation of the effect of the duration of WIC benefits on perinatal outcome is approached with two different analytic strategies, both using linear multiple regression analysis. In the first, receipt of WIC benefits was interacted with the duration of gestation at the onset of study observation. If effects of the WIC program on perinatal outcome are contingent on earlier initiation of benefits, the interaction of WIC participation and duration of gestation at onset of benefits should be negative: the earlier the duration of gestation at recruitment into the study, the larger the effects. In the second regression model, gestation at delivery was controlled and whether the women received WIC benefits was interacted with the duration of time of enrollment in the study (duration of gestation at delivery minus duration of gestation at study onset). In these analyses the rate of fetal growth is under study, since gestation at delivery is controlled.

Other Factors

State WIC Directors' Assessment of Local WIC Program Effectiveness and Perinatal Outcome. Evaluations by the State Administrators of local WIC programs were subjected to factor analysis: 1 factor accounted for 59.5 percent of the total variance in the 10 items. The items measuring the amount of counseling, quality of nutrition education, quality of individual care plans, overall compliance with Federal regulations and State policies, and overall rating of the WIC site had high loadings on this factor. Two other factors explained an additional 11.1 percent and 7.2 percent of the total variance. The items with high loadings on the second

factor were the efficiency of food/voucher distribution, integration with the health care system, and community outreach. Staff quality and morale had high loadings on the third factor. The large drop in the proportion of variance explained by factors derived subsequent to the first one suggests that there was really only one general quality factor. Indeed, the correlations among the three scores were high. The lowest correlation (0.59) was between the second and third factors. The first factor correlated 0.64 with the second factor and 0.71 with the third factor. Because the derived factors were so highly intercorrelated, it was concluded that the best presentation of the data was as a single scale. Therefore, each item was standardized and all 10 standardized item scores were added together to calculate a total score. While the mean summed item score for all programs was zero with a standard deviation of 7.64 (rather than 10, since the items were not independent of each other), the mean summed score, weighted by the number of women in each program, was less than zero (it was -0.47 or about one-sixteenth of a standard unit below the mean of all item scores in the analysis on duration of gestation). Thus, the average woman in the analysis was served by a program whose ranking was somewhat less than the mean of all programs.

The variable representing the State WIC Directors' perception of quality of program and whether or not an evaluation had been received from the State WIC Director were included in linear multiple regression analyses on perinatal outcomes. (All infants of women recruited from military base clinics were excluded from these analyses, see Chapter IV.)

Maternal Risk Characteristics. While the central concern of this chapter is the relationship between WIC program participation and perinatal outcome, there is much to be learned that is relevant to WIC program planning by considering other maternal characteristics related to perinatal outcome. For each perinatal outcome, statistically significant regression coefficients from two complementary regression analyses have been abstracted and are summarized: first, for all study recruits for whom there are outcome data, and second, for those women for whom data were available at followup in late pregnancy. The latter analysis is needed to relate change over the course of pregnancy to prenatal outcome. Both analyses are limited to women recruited into the study before the 196th day (28th week) of pregnancy and with delivery after the 140th day of gestation (20th week).

The analyses of birthweight, infant length, and head circumference are parallel with those for duration of gestation. The outcomes under study are mean birthweight and frequency of birthweight under 1,501 g. In addition, outcome was analyzed with control for duration of gestation at delivery to distinguish rate of fetal growth from the effects of length of gestation. (These latter analyses are not presented but are referred to when important to the understanding of the processes under study.)

Maternal factors at initial visit and during the course of the study were related not only to infant length and head circumference, but also to head growth, adjusted for birthweight, and then separately adjusted for

length. These separate analyses of head growth aimed to sort out the factors related to differential head growth, above and beyond its joint association with growth in weight and length.

Paired hemoglobin values were available for over 75 percent of the study population with abstracted hemoglobin and/or hematocrit in the prenatal record, the last prenatal measure, and the dates for both. For many women, both hemoglobin and hematocrit were available. Hematocrits were converted into grams of hemoglobin per 100 ml, and if both hematocrit and hemoglobin were available for the same date, a mean value derived from the two was used.

3. Results

WIC Program Participation

The Mean Gestational Age and the Frequency of Very Preterm (Under 33 Weeks Gestation) and Preterm Delivery (Under 37 Weeks Gestation). In this analysis, the available sample included 3,137 women in the WIC group at enrollment (2,789 who returned for followup visit and 348 who did not) and 798 controls (178 who by followup had been enrolled in the WIC program, 515 who had not, and 105 without a followup visit).

There were no significant relationships between WIC benefits and either mean duration of gestation or the frequency of early delivery (see Table V-23). In the regression model adjusted only for ethnicity and maternal gestation at initial interview the overall WIC sample had 0.33 day shorter gestation than controls, and in the fully adjusted model shorter gestation by 0.09 day. Those who did not return for late pregnancy followup had, on average, pregnancies 4 weeks shorter than those who did return (see Volume IV, Appendix V-E-3). Obviously, an important reason for not returning for followup was premature delivery.

Mean Birthweight and the Frequency of Birthweight Under 1,501 g and Under Under 2,501 g. Data were available for 3,021 women from the WIC group at enrollment (2,708 who returned for late pregnancy followup and 313 who did not) and 761 controls (175 who had been enrolled in the WIC program by followup, 497 who had not, and 89 without a followup visit).

There were no significant relationships between WIC status and mean birthweight or with frequency of birthweight under 1,501 g or 2,501 g, whether adjusted for duration of gestation or not. Among women for whom followup data were available, there were only trivial differences in the magnitude of estimated differences in birthweight with other mediating factors included in the analyses. Thus, changes in weight, skinfold thickness, reported caloric intake, or work patterns had little effect on the estimated differences in birthweight between WIC and control groups. The results of these analyses are summarized in Table V-23 (also see Appendix V-E-3).

Table V-23

Duration of Gestation, Birthweight, Length, Head Circumference, and Fetal Mortality[a,b]

Perinatal outcome	WIC Status at registration: WIC	Control
DURATION OF GESTATION		
Mean duration of gestation (days)		
Partially adjusted	-0.328	276.174
Fully adjusted	-0.087	275.981
Fully adjusted, with other maternal factors at initial visit	-0.080	275.976
Duration of gestation < 33 weeks (%)		
Partially adjusted	-0.797	3.939
Fully adjusted	-0.921	4.038
Fully adjusted, with other maternal factors at initial visit	-0.943	4.055
Duration of gestation < 37 weeks (%)		
Partially adjusted	-0.452	14.490
Fully adjusted	-1.210	15.094
Fully adjusted, with other maternal factors at initial visit	-1.278	15.148
Sample size (n)	(3,137)	(798)
BIRTHWEIGHT		
Mean birthweight (grams)		
without adjusting for duration of gestation		
Partially adjusted	-4.137	3258.176
Fully adjusted	-8.944	3262.017
Fully adjusted, with other maternal factors at initial visit	-6.920	3260.400
Adjusting for duration of gestation		
Partially adjusted	2.851	3252.595
Fully adjusted	-5.700	3259.425
Fully adjusted, with other maternal factors at initial visit	-3.296	3257.505

(continued)

Table V-23 (continued)

Perinatal outcome	WIC Status at registration: WIC	Control
Birthweight < 1501 grams (%)		
without adjusting for duration of gestation		
Partially adjusted	-0.275	1.198
Fully adjusted	-0.292	1.212
Fully adjusted, with other maternal factors at initial visit	-0.293	1.212
Adjusting for duration of gestation		
Partially adjusted	-0.357	1.264
Fully adjusted	-0.332	1.244
Fully adjusted, with other maternal factors at initial visit	-0.338	1.248
Birthweight < 2501 grams (%)		
without adjusting for duration of gestation		
Partially adjusted	0.234	7.560
Fully adjusted	0.475	7.368
Fully adjusted, with other maternal factors at initial visit	0.334	7.480
Adjusting for duration of gestation		
Partially adjusted	-0.071	7.804
Fully adjusted	0.330	7.484
Fully adjusted, with other maternal factors at initial visit	0.173	7.609
Sample size (n)	(3,021)	(761)
BIRTH LENGTH (cm)		
without adjusting for duration of gestation		
Partially adjusted	-0.271	50.386
Fully adjusted	-0.200	50.330
Fully adjusted, with other maternal factors at initial visit	-0.186	50.318
Adjusting for duration of gestation		
Partially adjusted	-0.203	50.332
Fully adjusted	-0.155	50.294
Fully adjusted, with other maternal factors at initial visit	-0.140	50.282
Sample size (n)	(2,834)	(720)

(continued)

Table V-23 (continued)

Perinatal outcome	WIC Status at registration WIC	Control
HEAD CIRCUMFERENCE (cm)		
Without adjusting for duration of gestation		
Partially adjusted	0.177*	33.849
Fully adjusted	0.201**	33.830
Fully adjusted, with other maternal factors at initial visit	0.206**	33.826
Adjusting for duration of gestation		
Partially adjusted	0.194*	33.836
Fully adjusted	0.202**	33.829
Fully adjusted, with other maternal factors at initial visit	0.208**	33.825
Sample size (n)	(2,536)	(693)
FETAL MORTALITY (20+ weeks) per 1000 live births and fetal deaths		
Partially adjusted	-5.724	15.298
Fully adjusted	-5.486	15.109
Fully adjusted, with other maternal factors at initial visit	-5.944	15.474
Sample size (n)	(3,192)	(813)

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Control group means and differences for WIC groups. Significance refers to difference from control group mean.

[b]Duration of gestation not adjusted for sex. See Volume IV, Appendix V-E-1, for specification of all covariates and mediating variables.

There is a concern that program benefits may have been obscured, not only by the enrollment of controls into the WIC program after recruitment into the study, but by initial disparities between the WIC and control samples. While this probably happened, it is unlikely to have altered outcomes since estimates of WIC effects from the regression analyses adjusted for a wide variety of maternal health and sociodemographic characteristics were only minimally different from the partially adjusted estimates. With all the limitations of any current observational study, the conclusion from this study was that there was no observed increased birthweight from enrollment in the WIC program. Caution in the interpretation of these results is suggested since the final study sample was con-

siderably smaller than had been originally planned, and to test a possible effect of the WIC program of 30 g at birth, at an alpha level of 0.05, the power of this study was only about 0.25. That is, if there was an actual birthweight effect of 30 g, there was a 75 percent chance of accepting the null hypothesis when it was, in fact, not true.

Infant Length. Data on length were available in the WIC group for infants of 2,834 women (2,537 who returned for late pregnancy followup and 297 who did not) and 720 controls (478 who were still controls at followup, 164 who were enrolled in the WIC program by followup, and 78 who did not return for followup). As shown in Table V-23, infant length was not significantly related to the mother's enrollment in the WIC program. In the partially adjusted analyses, infants of WIC mothers were 0.27 cm shorter than controls ($p = 0.08$). Control for gestation at delivery reduced this difference to -0.20 cm. The difference was -0.20 cm with full covariate adjustment, and -0.16 cm with adjustment for gestation at delivery (all not significant). Other possible mediating factors had almost no effect on estimates of WIC program effects for births for whom maternal data were available at followup.

The narrowing of the decrement in infant length with full adjustment was small and, as with the birthweight analyses, there is no evidence of a WIC program effect.

Infant Head Circumference. Head circumference measures were available for infants of 2,563 women in the initial WIC group (2,304 who returned for followup visit and 259 who did not) and 666 controls (440 who had not enrolled in WIC by followup, 155 who began the study as controls but were later enrolled in the WIC program, and 71 who did not return for followup).

In the partially adjusted model, the head circumference of children of WIC mothers was 0.18 cm greater than that of controls ($p = 0.02$), opposite in direction to the relationships with birthweight and infant length, and statistically significant. With adjustment for initial maternal factors (e.g., those known at registration into the study), the increment associated with the WIC program rose to 0.20 cm ($p < 0.01$). Controlling for duration of gestation at delivery did not affect the magnitude of this estimated program effect, nor did the inclusion in the analysis of potentially mediating factors assessed in late pregnancy. There was no evidence of any beneficial effect among initial controls who entered the WIC program prior to followup visit.

These results demonstrate an unexpected effect on fetal head growth relative to other body dimensions following maternal WIC benefits during pregnancy. This finding is parallel to an observation presented in the Study of Infants and Children in Chapter VI. Preschool WIC recipient siblings of the infants born to women in the Longitudinal Study were significantly shorter than older siblings who had never been in the WIC program, but the former had slightly larger heads. The accelerated head growth of these siblings was, however, not statistically significant and was observed only among children who had begun WIC benefits in prenatal life or early infancy.

It is unlikely that this is an idiosyncratic result associated with sibling pairs being in the same study category (i.e., prenatal WIC recruits) since most of the control children in the study of preschool children were offspring of current WIC recipient pregnant women and older siblings of infants in the WIC group in this analysis.

Given these two independent observations of differential infant head growth associated with prenatal WIC benefits, it is confusing why this phenomenon, if real, has not been observed in the past. One reason may be study power. Even with the smaller number of available controls than had been planned in the study design, this remains possibly the largest longitudinal study of nutritional supplementation during pregnancy ever performed in which infant head circumference was studied. Thus, the absence of past observations may well be a function of both the relative infrequency and the low power of past studies. Further, this difference was somewhat greater after extensive statistical adjustment for differences across study groups in maternal characteristics that were related to infant head size. This study was planned to be able to account in analysis for as much maternal and familial sociodemographic, medical, and nutritional variability across study groups as possible.

Given the results of the concurrent Study of Preschool Children (Chapter VI), it is reasonable to conclude that these results are real and are an impact of the WIC program. The implications of this effect on fetal head growth can become clear only as these children are followed into early childhood, to determine if these initial gains are sustained and whether they are reflected in differences in somatic, cognitive, and behavioral development.

Fetal Survival. Analysis of the effect of the WIC program on the rate of fetal death is limited to fetal deaths occurring among singleton births and occurring after 20 weeks gestation. (It was impossible to distinguish with certainty spontaneous from induced fetal loss prior to 20 weeks). Also, no analyses of late pregnancy mediating factors are presented, since most women with fetal loss did not have the opportunity to return in late pregnancy. One ectopic pregnancy was excluded. There were three fetal losses in which it was impossible to determine whether the pregnancy passed the 20th week of gestation, two in the WIC group, and one in the control group. These have not been included in analysis.

Among the 3,192 women in the initial WIC sample there were 31 fetal deaths, a rate of 9.7 per thousand, and among controls, 12 fetal deaths among 813 women, a rate of 14.8 per thousand. After adjustment for duration of gestation at initial interview and ethnicity, the rate of fetal loss in the WIC group was 5.7 per thousand lower than among controls (n.s.) and after adjustment for the larger covariate set, 5.5 per thousand lower (n.s.). Thus, while the magnitude of difference was large, it was not statistically significant. This study was too small to test adequately for an effect of the WIC program on late fetal survival.

Table V-24

Differences in Mean Birthweight and Proportion of Low Birthweight Births Between WIC Infants and Controls, Stratified by Initial Triceps and Subscapular Skinfold Thickness[a]

Percentile rank, maternal skinfold at initial visit	Birthweight (g)			
	Mean		Percent <2501	
	WIC	Control	WIC	Control
Triceps				
< 25th	-111.85	-90.63	+2.22	+0.98
25 - 49th	-93.03	-37.57	+0.58	-2.35
≥ 50th	-0.44	3,307.74	-0.77	7.45
(n)	(2998)	(864)	(2998)	(864)
Subscapular				
< 25th	-66.58	-23.95	+3.18	-0.47
25 - 49th	-67.17	-28.72	+0.65	+0.16
≥ 50th	+7.49	3,287.40	-0.61	7.07
(n)	(2978)	(856)	(2978)	(856)

[a]Note: Values are differences from the mean of controls over 50th percentile (which are underlined). Significance within control group refers to difference from controls ≥ 50th percentile. No significant differences between WIC and control groups. See Volume IV, Appendix V-E-1, for the full set of covariates.

Effects of the WIC Program on Birthweight Contingent on Maternal Skinfold Thickness. In a very small study, an English team (Viegas et al., 1982) observed that the only women (n = 12) whose infants were heavier than controls following high-protein, high-calorie supplementation in pregnancy were those with "inadequate" increase in triceps skinfolds (≤ 0.2 mm per week) during the second trimester of pregnancy. The English study was small, and there was much variability and inconsistency in results, probably due to the instability inherent in small numbers and consequent low power.

However, the results of the study warranted repetition, so two sets of analyses were performed addressing whether the effects of WIC benefits on birthweight might be contingent on initial maternal skinfold thickness. In the first set (see Tables V-24 and V-25), WIC benefits were interacted with

Table V-25

Changes in Differences Between WIC and Control Groups in Birthweight and Proportion of Low Birthweight Infants,[a] Given One Millimeter Change in Maternal Skinfold Thickness at Initial Evaluation[b]

WIC control differences, given 1 mm change in material skinfold thickness at initial evaluation	Birthweight (g)[b]							
	Mean				Percent < 2501			
	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)
Triceps	1.97	1.48	1.11	0.64	-0.27*	-0.25*	-0.26*	-0.23*
Subscapular	2.93	1.98	1.45	0.63	-0.22	-0.18	-0.20	-0.16

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Coefficients are differences from the control group mean. See Volume IV, Appendix V-E-1, for full set of covariates.

[b]Adjusted for (A) Maternal Risk Characteristics at Registration into Study, (B) as in (A) Plus Duration of Gestation at Delivery, (C) as in (A) Plus Maternal Weight at Conception, (D) as in (B) Plus Maternal Weight at Conception.

initial maternal triceps skinfold and maternal subscapular skinfold. The study population was stratified into three groups, separately for each skinfold site: those below the 25th percentile for the skinfold thickness at initial visit (the percentiles were derived from this study population, since external standards are sparse), those from the 25th to 49th percentile, and those at or above the 50th percentile. Differences in birthweight between infants of women initially recruited into the WIC study group and those of controls were assessed within each of the strata defined by initial maternal skinfold thickness.

Birthweight was lowest among infants of women with smallest triceps skinfold thickness and highest among those with the largest skinfolds (see Table V-24). (Maternal height, but not maternal weight, was controlled in this analysis.) However, there was no evidence of any greater effect of the WIC program given lower initial maternal skinfold thickness, whether or not duration of gestation was controlled.

In the second set of analyses to determine whether the effects of WIC benefits on birthweight were contingent on maternal skinfold thickness, the initial triceps skinfold is treated as a continuous variable. In Table V-25, the interaction between WIC benefits and initial maternal triceps skinfold on birthweight is positive (i.e., opposite the hypothesized direction), but not significant. (The positive direction means that, on average, differences in birthweight between WIC and control groups are greater the larger the initial maternal triceps skinfold.)

The interrelationship between initial maternal subscapular skinfold and WIC benefits on mean birthweight and frequency of birthweight under 2,501 g was similar to those for triceps skinfold. The direction of the relationship was opposite to that hypothesized, but none of the interactive relationships was significant.

Thus, smaller skinfolds in early and mid-pregnancy were found to predict lower birthweight (at least if maternal weight is not controlled), but were unrelated to response to WIC program benefits.

In the analysis on frequency of birthweight under 2,501 g, there is a significant interaction between initial triceps skinfold and WIC on outcome, but in the direction such that differences between WIC and control groups were more advantageous in the WIC group given larger initial triceps skinfold (0.27 percent greater decrease among WIC recipients compared to among controls with each increase of 1 ml in initial triceps skinfold, $p = 0.02$).

<u>Abnormalities of Labor and Delivery</u>.

Abnormalities of labor and delivery were compared at registration into the study, and several significant differences in outcome were found between WIC and control women (premature rupture of membranes, 5.7 percent among WIC women vs. 9.2 percent among controls [$p < 0.001$]); premature

labor, 2.9 percent in the WIC group vs. 4.2 percent among controls [p < 0.05]; and the umbilical cord wrapped around neck, shoulders, or upper torso, 5.2 percent in the WIC group vs. 8.6 percent among controls [p < 0.001]). Thus, the WIC group experienced significantly less pathology of labor and delivery, which may have resulted from better prenatal and post-natal health care or from generally improved physiological status associated with WIC benefits.

WIC Benefits and Maternal Risk Characteristics

In Table V-26, significant differences are presented in infant outcome associated with prenatal WIC benefits within strata defined by various maternal risk factors from fully adjusted analyses. In Volume IV, Appendix V-E-4, all relationships are presented, regardless of whether they were statistically significant, and for both the partially and fully adjusted analyses.

Significant relationships appear among selected maternal characteristics and perinatal outcome measures despite the small number of control births in some strata. In particular, control group women with a history of past low birthweight had, as might be expected, very poor pregnancy outcome, with a mean duration of gestation of 270 days, an 11.1 percent rate of delivery under 33 weeks duration, and a 3.3 percent rate of infants with birthweight under 1,501 g (see Table V-26). Similar women enrolled in WIC had significantly lower rates of very preterm delivery (4.3 percent, $p < 0.01$) and very low birthweight (0.72 percent, $p < 0.05$).

WIC was associated with greater increments in head circumference among multiparae than primiparae (0.28 cm greater than controls among women with one or two past births [$p < 0.01$], 0.27 cm greater than controls among women with three or more past births [(n.s.)], but only 0.07 cm among primiparae [n.s.]), and larger heads among infants of women in families with incomes under $3,000 a year (0.49 cm greater than controls, $p < 0.05$). Infants of women receiving both AFDC and Food Stamps were considerably larger if their mothers received WIC benefits than if not (3,330.0 g vs. 3,159.8 g birthweight, $p < 0.05$; 34.31 cm vs. 33.48 cm head circumference, $p < 0.01$).

Other relationships, while significant, did not suggest much in the way of regular differential benefit dependent on maternal weight, height, smoking history, Medicaid receipt, marital status, or whether working during this pregnancy.

Duration of WIC Benefits

The duration of WIC benefits was specified in two different ways for analytic purposes; the time of onset of WIC benefits (measured as the gestational age, in days, at program entry) and the actual duration of WIC benefits (measured as the difference, in days, between the date of delivery and WIC program entry). These measures are important to the current analyses because they have been hypothesized to relate directly (and positively) to maternal and newborn outcomes, and thus to WIC program effectiveness. That is, the longer the duration of benefits, or the earlier in

Table V-26

WIC Benefits and Perinatal Outcome Within Groups Stratified by Maternal Risk Characteristics[a,b]

Maternal risk characteristics	Duration of gestation: Mean (d) WIC	Mean (d) Control	% < 33 Weeks WIC	% < 33 Weeks Control	% < 37 Weeks WIC	% < 37 Weeks Control	Birthweight (g): Mean WIC	Mean Control	% < 1501g WIC	% < 1501g Control	% < 2501g WIC	% < 2501g Control	Length (cm) Mean WIC	Length (cm) Mean Control	Head circumference (cm) Mean WIC	Head circumference (cm) Mean Control	n (Birthweight only) WIC	n (Birthweight only) Control
Age (y)																		
< 18															-0.04*	34.20	479	86
18 - 19															0.41*	33.89	599	175
20 - 29															0.19	34.08	1684	522
< 30															-0.06	34.31	259	86
Parity (n)																		
0	-2.9*	281.3							0.19	0.76					0.07**	34.07	1324	402
1 - 2	1.3	278.6							-0.26*	1.16					0.28	34.02	1379	399
> 2	2.1	278.8							-2.84	2.64					0.27	34.26	318	68
Previous low birthweight																		
Parity 0	-2.8*	282.1	0.32	1.97					0.18	0.00					0.08**	34.18		
No	0.9	279.9***	-0.71**	1.10***					-0.22*	0.88*					0.30	34.07	1336	391
Yes	3.6	269.8	-6.06	11.13					-2.61	3.33					0.13	33.58	375	83
Weight at conception (kg)																		
< 50.35					0.92	11.64			-0.37	0.53					0.23	33.74	611	217
50.35 - 63.49					1.58*	8.45			0.62*	0.09					0.05*	34.22	1370	395
> 63.5					-5.14	11.34			-0.16	2.89					0.27	34.12	1040	257
Height (cm)																		
< 157.6							-26.9	3282.0*			4.56*	3.67			0.18*	33.91	752	207
157.6 - 162.6							1.7*	3326.0			-0.95	6.38			0.24	34.02	1011	314
162.7 - 167.5							-96.8	3416.4			2.45	4.10			-0.02	34.22	637	160
> 167.5							29.3	3393.6			-3.10	7.75			0.27	34.24	621	188
Cigarettes/day (n)																		
0															0.23*	34.21	1958	548
1 - 5															0.86	34.11	267	85
6 - 14															-0.03	33.85*	446	119
15+															0.26	33.68	350	117
Ethnicity																		
White Non-Hispanic	0.2	279.3											-0.05	50.47	0.21*	34.06	1489	443
White Hispanic	1.5*	278.6											0.15**	50.11	0.27	33.96**	417	192
Black	-3.8	277.7											-0.78	49.95	0.10	33.55	1027	189
Other	-2.3	280.7											-0.16	50.49	-0.16	34.24	88	45
Marital status																		
Married													0.10*	50.41	0.23*	34.09	1384	484
Not married													-0.53	50.72	0.11	34.08	1637	385
Living with father/ Household size (n)																		
No father, 1 in household			3.55	-0.89													97	28
No father, 2-3 in household			-3.83*	4.95													521	127
No father, ≥ 4 in household			1.31	1.08													772	156
Yes father, 2-3 in household			-1.15	2.45													914	328
Yes father, ≥ 4 in household			-1.02	2.24													715	226

See footnotes at end of table.

(continued)

Table V-26 (continued)

Maternal risk characteristics	Duration of gestation: Mean (d) WIC	Mean (d) Control	% < 33 Weeks WIC	% < 33 Weeks Control	% < 37 Weeks WIC	% < 37 Weeks Control	Birthweight (g): Mean WIC	Mean Control	% < 1501g WIC	% < 1501g Control	% < 2501g WIC	% < 2501g Control	Length (cm) Mean WIC	Length (cm) Mean Control	Head circumference (cm) Mean WIC	Head circumference (cm) Mean Control	n[a] (Birthweight only) WIC	n[a] (Birthweight only) Control
Education (y)																		
< 12															0.16*	34.10	1664	396
12+															0.21	34.04	1357	473
Income (dollars/100)																		
< 3,000	-2.4	281.1	1.52**	0.55*	3.49**	7.28*			-2.26*	3.35					0.44*	33.73	989	217
3,000 - 6,999	2.6	276.8*	-4.52	5.21**	-7.09	16.72 **			-1.64	2.04 *					0.28	33.93	486	81
7,000 - 12,999	-2.0	281.0	0.95	1.32	0.76	8.43			0.07	0.53					0.10	34.13	767	325
13,000	2.9*	277.9***	-1.80	2.93*	-4.11*	10.40***			1.32	-0.03*					0.34	33.98*	308	116
Missing	-4.6	284.7	0.97	0.80	7.33	1.68			1.15	-0.16					0.00	34.41	471	130
AFDC/Food Stamps																		
Nonparticipant							-40.8	3365.6	0.27	0.97			-0.19	50.61	0.08	34.23	1516	626
AFDC							125.7	3265.1	0.91	0.12			1.60*	48.90	0.41	33.83	109	16
Food Stamps							-29.1*	3355.0**	0.02**	1.20			-0.66	51.01*	0.25**	34.14**	877	175
AFDC and Food Stamps							170.2	3159.0	-6.67	7.38			0.92	49.43	0.83	33.48	519	52
Medicaid																		
No															0.19*	34.05	2298	656
Yes															0.14	34.12	723	213
Employment status																		
Not working															0.18*	34.00	2528	651
Working at T_1/No T_2 data															-0.65	34.25	33	24
Working at T_1/Not working at T_2															-0.01	34.25	235	103
Working at T_2															0.43	33.99	225	91

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Initial control group means and differences from controls for initial WIC recruits. Significance refers to difference from control group means or from reference group (which is underlined).

[b]See Volume IV, Appendix V-E-1, for full covariate list.

pregnancy a woman begins prenatal food supplementation and health care, the greater the potential impact of the program on pregnancy outcomes. The distinction between the two measures is made because, for certain analyses, the measure of duration of WIC benefits is confounded by the duration of gestation. In such cases, the gestational age at WIC program entry (e.g., time of onset of benefits) is the preferred measure.

Duration of Gestation. As summarized in Table V-27, the duration of gestation at entry into the WIC program or prenatal care (controls) was not significantly associated with either mean duration of gestation or early delivery (<33 weeks and <37 weeks).

Birthweight. The effect of duration of gestation at onset of WIC program benefits (entry into the study) on birthweight was not statistically significant (see Table V-27 for greater detail). The direction of these coefficients was in the predicted direction (those with earlier entry into the program had better outcomes relative to controls), while the direction of coefficients for the duration of the study period and WIC benefits was mixed. In one analysis, for the frequency of birthweight under 1,501 g, the interaction of duration of study period and WIC benefits was significant. However, the direction of the effect was opposite to that predicted while this pattern did not apply to the rate of birthweight under 2,501 g. It is difficult to postulate this as a negative program effect since the dichotomous variable, WIC vs. others, was significant in the beneficial direction, and this adverse relationship was not present in analyses of rates of birthweight under 2,501 g.

Infant Length. None of the relationships between the duration of the study period and WIC benefits and infant length were statistically significant, and their direction was opposite the predicted direction. These results are summarized in Table V-27.

Infant Head Circumference. The relationship of infant head circumference, receipt of WIC, and the stage of gestation at study entry was opposite to the predicted direction, but not significant (see Table V-27). The relationship of duration of the study period to head growth in the fully adjusted regression model was in the predicted direction and was significant ($p < 0.05$). This indicates a gestational age effect but not a differential effect due to WIC program participation.

Other Factors

State WIC Directors' Assessment of Local WIC Program Effectiveness and Perinatal Outcome

Duration of Gestation--The State WIC Directors' perception of program quality was consistently, and at times almost significantly, related to shorter duration of gestation.

In the fully adjusted models, an increase in one standard unit of the ranking score was associated with a decreased mean duration of gestation of

Table V-27

Duration of WIC Benefits and Perinatal Outcome by Duration of Gestation at Entry Into Study, and by Duration of Study Period (Duration of Gestation at Delivery Minus Gestation at Entry into Study)[a,b]

Regression coefficients	Duration of gestation at delivery			Birthweight (g)			Length (cm)	Head circumference
	Mean (d)	% < 33 Weeks	% < 37 Weeks	Mean (g)	% < 1501g	% < 2501g	Mean	Mean
WIC (vs. controls)[b]	-2.015	0.57	0.15	11.055	0.14	0.19	-0.877	0.068
Duration of gestation at study entry (days)	0.033	-0.01	-0.01	-0.204	-0.01	0.00	-0.004	-0.003
WIC × duration of gestation at study entry (days)	0.012	-0.01	-0.01	-0.255	-0.00	0.00	0.006	0.001
WIC (vs. controls)[b]	--	--	--	11.624	-4.49**	-0.15	0.399	0.214
Duration of study period (days)	--	--	--	0.935*	-0.02*	-0.03	0.004	0.003*
WIC × duration of study period (days)	--	--	--	-0.134	0.03**	0.00	-0.003	0.000
n WIC		3137			3021		2834	2563
n Control		904			869		822	764

*p < 0.05.
**p < 0.01.
***p < 0.001.

-- = Not applicable.

[a]Regression model of this analysis:
Duration of gestation (either at study entry or over the entire study period) = WIC participation + duration (time) + (WIC × duration) + all other covariates.

[b]Coefficient is difference from the control group mean. See Volume IV, Appendix V-E-1, for full set of covariates.

0.9 day ($p = 0.058$) and an increase in delivery under 37 weeks gestation of 1.11 percent (n.s.). Thus, the spread between the 16th and 84th percentile on the quality scale would be about 1.8 days in mean gestation and a 2-percent difference in preterm delivery. Table V-28 summarizes these findings.

Birthweight--The State WIC Directors' perception of the quality of local WIC programs was regularly and significantly related to increased birthweight and decreased rates of low-birthweight delivery (see Table V-28).

There were strong relationships between birthweight and whether the State WIC Director returned the quality scoring form. Among the 1,060 WIC births from States with unreturned forms, mean birthweight was 63.4 g lower than among controls ($p = 0.003$). Among those whose forms were returned, at mean clinic rank, birthweight was 16.3 g greater than among controls (n.s.) and 16.5 g greater with an increase of one unit of standard score (n.s.). Controlling for duration of gestation, mean birthweight among WIC recipients in unranked programs was 56.9 g lower than controls ($p = 0.003$), and mean birthweight among WIC recipients in ranked programs was 17.8 g greater than controls (n.s.). Among those in ranked clinics, one standard unit increase in ranking score was associated with 25.9 g greater birthweight ($p < 0.01$). Thus, the estimated difference in mean birthweight among women in clinics separated in quality by two standard units (e.g., between the 16th percentile of perceived quality of program and the 84th percentile) was 51.8 g, slightly greater than the effect of the WIC program that was originally predicated when this study was designed.

The frequency of birthweight under 2,501 g was 1.4 percent lower for each standard unit increase in quality score ($p < 0.01$) and 1.9 percent, controlling for duration of gestation ($p < 0.001$). Thus, fetal growth was markedly and significantly greater, given the State WIC Directors' judgment of program quality. Mean birthweight was considerably lower in the States where WIC Directors did not return evaluations of local WIC programs. Possibly this too is a sign of suboptimal WIC program quality, but it is more likely that programs in three of the five largest metropolitan areas of the United States were not ranked, and these urban populations probably included a disproportionate number of high-risk women. Certainly it is evidence of wide variation across States in the relationship of WIC benefits and outcome, due either to differences in program effectiveness or in the level of risk of the pregnant women certified into the program.

Head Circumference--The mean head circumferences of WIC recipients in States without returned evaluations were significantly lower than controls (0.15 cm; $p < 0.05$), while the mean in States with evaluations was much higher than controls (0.26 cm; $p < 0.01$). The ranking score was significantly related to head circumference (0.08 cm increase with one standard unit change in the program quality score; $p < 0.05$). This relationship was highly significant after control for duration of gestation (0.10 cm increase in head circumference with one standard unit change in program

Table V-28

State WIC Directors' Evaluation of WIC Program Quality and Perinatal Outcome[a,b,c]

	Duration of gestation at delivery			Birthweight (g)						Head circumference (cm), mean	
						% < 1,501		% < 2,501			
	Mean (d)	% <33 weeks	% <37 weeks	Mean not controlled for duration of gestation	Mean controlled for duration of gestation	Not controlled for duration of gestation	Controlled for duration of gestation	Not controlled for duration of gestation	Controlled for duration of gestation	Not controlled for duration of gestation	Controlled for duration of gestation
Mean, control group[d]	277.16	3.78	14.81	3,264.16	3,261.61	1.11	1.14	7.52	7.63	33.89	33.89
WIC,[e] without ranking vs. controls	-.47	-.12	-1.14	-63.35**	-56.89**	.38	.30	.39	.10	-.15*	-.13
WIC,[e] with ranking, vs. controls	-.04	-.86	-.70	16.32	17.75	-.47	-.48	.23	.16	.26**	.25**
Ranking (change per standard unit)	-.87	.19	1.11	16.47	25.87*	-.41	-.52*	-1.44*	-1.86***	.08	.10**
n Control		798				761					666
n WIC without ranking		1,092				1,060					849
n WIC with ranking		2,045				1,961					1,714

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]135 programs evaluated by 22 State WIC Directors for 2,045 women with known gestation at delivery (no evaluation received from five states for 39 programs serving 1,092 women from our initial WIC sample with known gestation at delivery).

[b]Values are differences from the control group means.

[c]See Volume IV, Appendix V-E-1, for full set of covariates.

[d]Controls at recruitment, excluding those recruited from military base hospitals.

[e]WIC at recruitment. Coefficients in same column not adjusted for duration of gestation at delivery; coefficients in columns adjusted for duration of gestation are equivalent to rate of fetal growth.

quality score; $p < 0.01$). While mean head circumference among infants of mothers who received WIC in States without returned evaluation was still smaller than controls with control for duration of gestation (0.13 cm less), this difference was not significant. Table V-28 summarizes these results.

Discussion--It is evident that State WIC Administrators can distinguish differences in the performance of local WIC programs and that the perception of WIC program quality is strongly linked to measured fetal growth. These results imply very different limits to possible change in fetal growth with nutritional intervention in pregnancy than do the results of the central study analyses. It will be a challenge to future research to identify the specific program characteristics that are associated with improved outcome, so that less effective local WIC programs might be brought to the level of more successful programs.

<u>Maternal Risk Characteristics</u>. Unless otherwise stated, all results cited below are presented in Tables V-29 and V-30.

Duration of Gestation--The following factors, assessed in early pregnancy, were related significantly to shorter mean duration of gestation: black ethnicity (4.6 fewer days compared to whites, $p < 0.001$), history of past low-birthweight delivery (3.7 days, $p < 0.001$), larger triceps skinfold thickness (0.20, $p < 0.001$), mother never having worked (2.3 fewer days vs. mother in manufacturing, physical labor, or service occupation, $p < 0.05$), and with father never having worked (2.7 fewer days vs. father in manufacturing, physical labor, or service occupations, $p < 0.05$). Duration of gestation was positively associated with maternal education (0.42 day longer with each year of increased schooling, $p < 0.05$), and father working in a professional occupation (4.4 days longer than if father in manufacturing or service occupation, $p < 0.05$).

The relationship of duration of gestation to maternal weight was complex: a positive relationship to weight at conception (0.16 day per kilogram, $p < 0.05$) but negative to weight at interview (0.19 fewer day per kilogram, $p < 0.01$). (The relationship to weight at interview, or weight change, was only significant when triceps skinfold was included in the analysis.) The negative relationship of weight change from conception to interview with duration of gestation may be an artifact, reflecting inherent error in measurement of duration of gestation. If duration of gestation at interview is not perfectly measured (and it is not), on average, among a set of women reporting the same duration of gestation, women who have gained more weight will have more advanced pregnancies than those who have gained less weight, and their durations of gestation at delivery will thus appear to be short. The relationship of weight gain to duration of gestation cannot be fully elucidated from these analyses.

In late pregnancy, increase in reported alcohol intake during pregnancy was significantly related to longer gestation ($p < 0.01$). This may reflect decreased intake by women with known problem pregnancies but does not substantially modify the adverse relationship of alcohol with outcome

Table V-29

Factors Significantly Related to Perinatal Outcome (Includes all Women with Known Perinatal Outcome)[a] Regression Coefficients, Adjusted to Maternal Risk Characteristics at Registration into Study and Change During Study Participation[b]

Regression coefficients	Duration of gestation: Mean (d)	Duration of gestation: % <33 Weeks	Duration of gestation: % <37 Weeks	Birthweight: Mean (g)	Birthweight: % <1501g	Birthweight: % <2501g	Length (cm)	Head circumference (cm)
Characteristics at onset of study:								
WIC at registration								0.21*
Duration of gestation at registration (d)	0.05***	0.02*						-0.00*
Parity (n)				42.58***				0.12**
Previous low birthweight infant (n)	-3.70***	2.49***	5.03***	121.70***		4.18***	-0.75***	-0.29***
Previous stillborn infant		5.83**	9.66*					
Sex of infant (Male=1)				126.57***		-2.77**	0.84***	0.61***
Mother married				51.15*				
Weight at conception (kg)	0.16*							
Weight at registration (kg)	-0.20**		0.29**	7.50***				
Height (cm)		0.11*	-0.18*	8.07***			0.07***	0.02***
Cigarettes/day at registration (n)				-14.00***		0.37***	-0.08***	-0.03***
Alcohol consumed/week at registration (oz.)						1.44**		
White Hispanic vs. White Non-Hispanic								
Black vs. White Non-Hispanic	-4.56***	2.90***	6.16***	-204.33***		4.80***	-1.18***	-0.60***
Income missing				51.34*				
Household size (n)	-0.41*		0.86**					
Mother's education (y)	0.42*							
Mother employed vs. housewife, student, disabled				232.29**				
Mother unemployed vs. housewife, student, disabled			3.40*					
Hours work/week at registration (hr)				-4.06*				
Hours on feet at work/week of registration (hr)				47.35*				
Mother professional vs. physical labor, service, manufacturing					2.34*			
Mother never worked vs. physical labor, service, manufacturing,	-2.30*		3.08*					-0.17*
Father retired, in jail, deceased, disabled, student, vs. unemployed								-0.23*

See footnotes at end of table.

(continued)

Table V-29 (continued)

Regression coefficients	Duration of Gestation: Mean (d)	Duration of Gestation: % <33 Weeks	Duration of Gestation: % <37 Weeks	Birthweight: Mean (g)	Birthweight: % <1501g	Birthweight: % <2501g	Length (cm)	Head circumference (cm)
Father professional vs. physical labor, service, manufacturing	4.37*							
Father never worked vs. physical labor, service, manufacturing,	-2.66*							
AFDC		1.69*						
Hemoglobin at registration (g/100 ml)				-23.58**		0.96*		
Missing hemoglobin (g/100 ml)	-2.92**	2.53**	3.88**					-0.18*
Mean triceps skinfold at registration (mm)	0.20***	-0.10*	-0.21*					
Mean subscapular skinfold at registration (mm)				-5.27**				
n WIC		3137			3021		2834	2563
n Control		798			761		720	666

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Excludes births prior to 140 days gestation and women registered after 196 days gestation.

[b]See Volume IV, Appendix V-E-1, for full covariate list.

Table V-30

Factors Significantly Related to Perinatal Outcome (Includes Only Women With Followup and Known Perinatal Outcome)[a]
Regression Coefficients, Adjusted for Maternal Risk Characteristics at Registration[b]

Regression coefficients	Duration of gestation: Mean (d)	Duration of gestation: % < 33 weeks	Duration of gestation: % < 37 weeks	Birthweight: Mean (g)	Birthweight: % < 1,501 g	Birthweight: % < 2,501 g	Length (cm)	Head circumference (cm)
Characteristics at onset of study:								
WIC		-0.60*						0.18*
WIC/control								
Duration of gestation at registration (d)	0.041***			-0.57*				-0.00*
Sex of infant (male=1)				118.86***		-1.94*	0.80***	0.54***
Parity (n)				32.79**				0.12**
Previous low birthweight infant (n)	-1.55**		2.25*	-96.49***		2.45**	-0.61***	-0.18**
Previous stillborn infant (y=1)		1.71*	10.10*			9.10**		
Mother married (y=1)				48.23*				
Weight at registration (kg)				7.90***			0.03**	0.03***
Height (cm)				7.87***			0.07***	0.02***
Cigarettes/day at registration (n)				-13.55***		0.33***	-0.08***	-0.03***
Alcohol/week at registration (oz.)					0.47***	1.35**		
White Hispanic vs. white non-Hispanic				-64.14**				
Black vs. white non-Hispanic	-2.55***		4.42**	-191.10***		4.03***	-0.93***	-0.56***
Household size (n)								
Medicaid (y=1)	-1.50*		2.69*					
Mother employed vs. housewife, student, disabled				217.13**				
Mother unemployed vs. housewife, student, disabled					0.59*			
Hours work/week (h)				-4.45**				
Hours on feet at work/week (h)	1.86**						0.31*	
Exertion at work (1=heavy, 4=light)						4.46*		
Mother professional vs. physical labor, service, manufacturing					1.40*			
Mother nevery worked vs. physical labor, service, manufacturing	-1.95**							
Father retired, in jail, disabled vs. unemployed								-0.29**

See footnotes at end of table. (continued)

Table V-30 (continued)

Regression coefficients	Duration of gestation: Mean (d)	Duration of gestation: % < 33 weeks	Duration of gestation: % < 37 weeks	Birthweight: Mean (g)	Birthweight: % < 1,501 g	Birthweight: % < 2,501 g	Length (cm)	Head circumference (cm)
Hemoglobin at registration (g/dl)				-22.24**				
Mean triceps skinfold at registration (mm)	0.14**							
Mean subscapular skinfold at registration (mm)				-4.33**				
Changes during study participation:								
Weight at followup (kg)				13.31***		-0.20*	0.05***	0.04***
Weight at followup missing (missing=1)						7.13*		
Duration of gestation at followup (d)	0.12***	-0.02***	-0.25***			-0.07**		
Cigarettes/day at followup (n)				-6.10**		0.25**	-0.06***	-0.01*
Alcohol/week at followup (oz)	1.49**							-0.12*
Hours work/week at followup (h)								
Hours on feet at work/week at followup (h)								
Exertion at work (1=heavy, 4=light)			7.49*					
Hemoglobin at followup (g/dl)				-17.86*				
Mean triceps skinfold at followup (mm)								
Mean subscapular skinfold at followup (mm)				-3.88*				-0.02*
Number of prenatal visits at followup	-0.36***		0.52**					
Number of days experienced nausea (d)		0.01*						
Calories per day at followup (kcal)				-0.02*	0.00*			
n WIC		2,789			2,708		2,537	2,304
n WIC/control		178			175		164	155
n Control		515			497		478	440

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Excludes births prior to 140 days gestation and women registered after 196 days gestation.

[b]See Volume IV, Appendix V-E-1, for full covariate list.

(see below). The number of prenatal visits was related to shorter duration of gestation ($p < 0.001$). This latter finding may reflect increased visits prescribed for women with known problem pregnancies.

Frequency of Delivery Under 33 Weeks and 37 Weeks Gestation--The following factors at initial interview were associated with increase in delivery both under 33 and 37 weeks gestation: black ethnicity, past low-birthweight delivery, past stillbirth, and lower weight gain from conception to initial interview. In addition, very early delivery was significantly related to shorter maternal height, and delivery under 37 weeks duration to smaller triceps skinfold, to mother never having worked, and to larger household size.

Among factors assessed in late pregnancy, the number of days of nausea was related to very preterm delivery ($p < 0.05$). The number of increased prenatal visits was related to preterm delivery: this may be circular, with more visits required by problem pregnancies. The relationship with increase of exertion at work during pregnancy (lower rates of preterm delivery with higher exertion, $p < 0.05$) runs counter to much current information. Exertion at initial interview was not related to outcome, and decreased exertion may therefore have followed from problems during pregnancy, rather than being causal.

Discussion--The set of factors associated with duration of gestation in this study reflects much that is known and some things that have not been identified in the past. (It is important to remember that all of these relationships are independent of each other; each regression coefficient represents relationships net of all other factors concurrently in the analysis.) Blacks and women with a past history of low-birthweight delivery or stillbirth have long been known to have an increased probability of shorter duration of gestation. Low social status is strongly associated with short gestation. The current results reflect these relationships. Gestation was shorter if mother or father never worked and with lower maternal education and longer if father was a professional.

The significantly longer duration of gestation with increase in alcohol intake in late pregnancy will be discussed after the review of all perinatal outcomes. The relationship of triceps skinfold to longer duration of gestation was strong and probably important. There is no past report that this index of available energy stores in early pregnancy is implicated in longer duration of gestation. In fact, there would be a tendency for a spurious relationship between larger triceps and shorter gestation, with the same reasoning used for weight gain: at a given reported gestation in early pregnancy, larger triceps skinfold, on average, should be associated with later actual gestation. Thus, the observed relationship is all the more likely not to be spurious and opens a new line of speculation on the relationship of maternal nutritional status in early pregnancy to perinatal outcome.

Mean Birthweight--Maternal characteristics at initial interview associated with lower mean birthweight were black ethnicity, history of past low-birthweight delivery, low parity, short maternal height, low weight

gain from conception to initial interview, cigarette smoking, being unemployed, the number of hours worked each week and the proportion of sedentary work time, and being unmarried. Hemoglobin level was negatively related to birthweight, probably reflecting the positive relationship of expanded maternal plasma volume to fetal growth. With control for duration of gestation, the negative relationship of hemoglobin to fetal growth was strengthened ($p < 0.001$). The bivariate relationship of subscapular skinfold thickness with birthweight was positive ($r = 0.101$, $p < 0.001$), but after adjustment for height, weight gain, triceps skinfold, and other factors, was negative ($p < 0.01$). Late pregnancy factors associated with lower mean birthweight were cigarette smoking, higher reported caloric intake at followup (this may reflect the prescription of restrictive diets among women with high pregnancy weight gain), low weight gain, greater increase in subscapular skinfold thickness, and higher hemoglobin. With control for duration of gestation at delivery, the most important relationship that emerged is a near significant negative relationship with alcohol intake (31 g decreased birthweight with each ounce of alcohol per week, $p = 0.055$). There also is a significant relationship to number of prenatal visits, possibly reflecting increased attention to health care or an effect of health care.

Frequency of Birthweight Under 1,501 g and 2,501 g--The only maternal characteristic at initial exam associated with lower frequency of birthweight under 1,501 g was maternal professional occupational status. The frequency of birthweight under 2,501 g was increased among blacks, those with a history of past low-birthweight delivery or past stillbirth, with number of cigarettes smoked, with higher hemoglobin, and with alcohol intake (1.4 percent increase per ounce of alcohol per week, $p < 0.01$). The rate was significantly lower if the father had professional occupational status. With control for duration of gestation, no additional factors emerged that were related to birthweight under 1,501 g; low maternal weight gain to initial interview did relate significantly to the rate of low birthweight controlled for duration of gestation.

The only late pregnancy factor related to frequency of birthweight under 1,501 g was increased caloric intake at followup (controlled for initial intake). Since caloric intake tends to fall off in very late pregnancy, this observation may reflect only that women who delivered very early had to have very early late pregnancy followup as well. Both cigarette smoking and low weight gain were related to increased frequency of birthweight under 2,501 g. With control for duration of gestation at delivery, increased alcohol intake in late pregnancy was significantly associated with higher frequency of birthweight under 2,501 g (2.0 percent increase in likelihood per ounce of alcohol each week, $p < 0.01$).

Infant Length and Head Circumference--Only four factors assessed at initial visit were associated with reduced infant length: black ethnicity (1.18 cm less, $p < 0.001$), mothers' height (0.07 cm less in infant length with each reduction of 1 cm in maternal height, $p < 0.001$); smoking (0.08 cm reduction with each cigarette reported, $p < 0.001$); and number of past low-birthweight deliveries (0.75 cm less with each such birth, $p < 0.001$). With adjustment for duration of gestation at delivery (thus as-

sessing the rate of change of fetal length), the following additional factors were significantly related to infant length: maternal weight gain from conception to initial visit, lower hemoglobin, and maternal occupation in sales and skilled trades, or professional occupations, compared to those in manufacturing and service. (Those women who never worked also had significantly longer infants than those in manufacturing and service, the reference group.)

The late pregnancy factors significantly associated with infant length were smoking (0.05 cm less with each cigarette, $p < 0.001$) and maternal weight gain to followup visit ($p < 0.001$).

Smaller infant head circumference was associated with black ethnicity, smoking, shorter height, past low-birthweight delivery, and low weight gain from conception to initial visit. Maternal parity was associated with larger infant head circumference, and infants of mothers who had never worked had significantly smaller heads than the reference group, mothers working in manufacturing and service. Infants whose fathers were in a catch-all employment category, retired, in military service, or in jail (or dead) had significantly smaller head circumference than the reference group, infants of fathers currently unemployed. The pattern of factors associated with rate of fetal head growth (head circumference adjusted for duration of gestation at delivery) was essentially identical.

At followup visit, increase in maternal smoking (negatively) and weight gain (positively) were related to infant head circumference. In addition, increase in alcohol intake also was related to reduced head size, as was larger subscapular skinfold thickness. After control for duration of gestation, the relationship with alcohol became stronger, from 0.12 cm less for each ounce of alcohol per week ($p < 0.05$), to 0.16 cm less, ($p < 0.01$).

The following maternal factors assessed at initial interview were related significantly to differential head growth, relative to body mass (i.e., head circumference adjusted for birthweight): black ethnicity ($p < 0.01$), father in sales or skilled trade vs. manufacturing, physical, labor or service ($p < 0.05$), and father retired, in service, etc., vs. those unemployed ($p < 0.01$). With adjustment for duration of gestation, head circumferential growth adjusted for birthweight was significantly related to maternal weight gain from conception to initial assessment. Differential infant head growth relative to linear growth (i.e., head circumference adjusted for infant length) was significantly depressed with smoking, lower parity, and history of past low-birthweight delivery and among blacks, among infants whose mothers had never worked, and among infants whose fathers were in service. Importantly, it was also significantly depressed with lower weight gain from conception to initial assessment. Controlling for duration of gestation at delivery (i.e., assessing rate of differential fetal head growth relative to length) did not greatly affect these relationships.

Among the factors assessed in late pregnancy, infant head growth relative to body weight (head circumference adjusted for birthweight) was significantly related to maternal weight gain and negatively to increased alcohol intake, both with and without control for duration of gestation at delivery. Infant head circumference adjusted for infant length also was negatively related to increased alcohol intake during study observation, positively to maternal weight gain, but, also, in the analysis adjusted for duration of gestation, negatively to subscapular skinfold.

Fetal Death--Preliminary study analyses included some very early fetal losses that proved to be induced abortions. Because of ambiguity about whether other early losses may have been induced abortions, the current analysis was limited to fetal loss after the 20th week of gestation. Also, given that many women who delivered fetal deaths could not return for followup assessment, this discussion is limited to factors assessed at initial interview.

Factors significantly related to fetal loss were maternal parity (4.4 per 1,000 fewer fetal deaths with increase in parity, $p < 0.05$) and mothers' education (3.4 per 1,000 fewer fetal deaths for each additional year of schooling, $p < 0.001$). Initial hemoglobin concentration was related to increased rates of fetal death at the margins of significance (3.2 per 1,000 more fetal deaths with each increased gram of hemoglobin concentration, $p = 0.053$).

Discussion--The factors associated with fetal growth that require further consideration, either because they were new, unexpected, or counterintuitive, or relate to the WIC program, were hemoglobin levels, work history, caloric intake at followup, subscapular skinfold thickness, alcohol ingestion, and smoking.

Hemoglobin--Results of this evaluation were consistent with all other studies reviewed that relate hemoglobin concentration to fetal growth: there is a strong negative relationship, at least for levels of hemoglobin above about 8 grams per deciliter. This reflects the greater acceleration of plasma volume expansion than of the relatively more static total red cell mass and probably does not reflect adequacy of iron intake one way or the other. Neither infant length nor head circumference, however, was associated with initial hemoglobin level, and final hemoglobin was (barely) associated only with infant length (0.11 cm decrease with each 1.0 gm percent increase in hemoglobin). The weak relationships of hemoglobin level with head growth and infant length may thus reflect a masked positive association of hemoglobin with these indices, relative to birthweight. Given the relationship of head circumference to WIC benefits, as well as with alcohol intake, this possibility cannot be dismissed.

Work History--Birthweight was much higher among employed than unemployed women, which may reflect resources expendable on food or better overall general health of the employed (the "healthy worker" effect).

Among those employed, birthweight was negatively related to the hours worked each week and positively with the number of hours of standing during work: from these data it is impossible to judge whether the proportion of work time standing reflected greater initial vigor and better health or was causally related to outcome. These issues are important both to the understanding of the physiology of pregnancy and for occupational policy aiming to maximize perinatal health.

Caloric Intake at Followup--There was an inverse relationship of reported caloric intake in late pregnancy with birthweight. This may reflect advice by care givers to women with high pregnancy weight gain to limit caloric intake. In any case, the relationship is not a strong one and requires further investigation.

Subscapular Skinfold Thickness--The authors know of no past research or other information that predicts a negative relationship between subscapular skinfold and fetal growth, even after adjustment for other indices of available fat stores (e.g., weight and triceps skinfold). These relationships with subscapular skinfold thickness emerge only after adjustment for maternal weight, weight gain, and triceps skinfold. Thus, at a given weight, weight gain, and triceps skinfold thickness, lower subscapular skinfold thickness implies less truncal body fat and consequently greater amounts (and changes) in other tissues, specifically, fluid volume (and especially plasma volume), products of conception, and peripheral fat. The raw (bivariate) correlation between subscapular skinfold thickness at study onset and birthweight was 0.101 ($p < 0.001$). Thus, the significant negative findings, holding constant weight, weight gain, and triceps skinfold, may reflect a relationship between accelerated maternal fluid and plasma volume expansion, and fetal growth.

A series of analyses were performed to test whether the relationships of maternal skinfold thickness and change in skinfold thickness with perinatal outcome were contingent on maternal weight or on simultaneous adjustment for the complementary skinfold measurement. First, both triceps and subscapular skinfolds at initial interview, taken separately, are significantly related to longer duration of gestation at delivery. The relationship of triceps skinfold is independent of maternal weight, weight change, or subscapular skinfold. The relationship with subscapular skinfold, however, disappears when triceps skinfold is controlled. With weight and weight gain controlled, initial triceps skinfold was significantly related to reduced preterm delivery; i.e., at constant weight and weight gain, greater fat stores are associated with less frequent preterm delivery. Given constant weight, relatively greater stores of peripheral fat are more advantageous than weight distributed among other tissues.

The only skinfold change between study registration and followup that was significantly related to longer duration of gestation was increased deposition of truncal (subscapular) fat stores in the analysis in which neither weight nor triceps skinfold was controlled. The most complex set of relationships was between maternal fat stores and mean birthweight (there were no significant relationships with the likelihood of birthweight under 2,501 g).

At initial interview, either skinfold measure taken alone was highly significantly related to birthweight. Taken simultaneously, the relationship with triceps skinfold was unchanged and that for subscapular skinfold was essentially zero. With control for weight and weight gain, the relationship with triceps skinfold was no longer significant; only with control for weight and weight gain did the highly significant negative relationship of subscapular skinfold thickness emerge. At followup, increase in triceps skinfold from initial evaluation was significantly related to birthweight. Only with control for weight and weight gain was change in subscapular skinfold (negatively) related to birthweight. The nature of the relationship of skinfold change to infant head circumference was parallel.

Thus, the significant negative relationships between subscapular skinfold thickness and birthweight emerge only with control for triceps skinfold and weight and weight gain. Raw subscapular skinfold was positively related to birthweight; differential subscapular skinfold thickness was negatively related to birthweight. This is a subtle relationship and not obviously amenable to program intervention. It is in all likelihood a function of individual maternal metabolic variation: given energy intake, fat deposition, and weight gain, it is less advantageous to the fetus that such weight gain/fat deposition be subscapular (truncal) fat; and there is no easy prescription to influence such patterns.

The relationship of the triceps skinfold to fetal growth is far simpler. It is significant when considered without control for maternal weight and weight gain and no longer significant after control for weight and weight gain: clearly, peripheral fat stores (triceps skinfold) and change in triceps skinfold share considerable variance with body weight and weight gain, and these indices are thus expressing much in common; they are measurements that are, to a large extent, interchangeable and indistinguishable. The distinct character of the stores of truncal fat is unexpected and warrants further attention in the controlled environment of the metabolic ward.

The relationships of maternal skinfold to infant length and head circumference were generally parallel with those for birthweight but much less strong and do not warrant separate detailed consideration at this time. Clearly, maternal fat stores relate more strongly to infant weight than to linear or head circumferential growth.

Ethanol Intake--There was significantly greater likelihood of low birthweight with greater alcohol intake in early pregnancy. When early and late pregnancy alcohol intake are considered simultaneously, the relationship is far stronger with late pregnancy intake. Given that increased alcohol intake in late pregnancy was significantly related to slightly longer duration of gestation, the relationship to fetal growth retardation is all the more striking. An extensive series of questions was asked at registration on usual amounts and types of alcohol ingested by the mother and again at followup. In initial analyses, alcohol intake from beer (coded as ounces of ethanol per week) was analyzed separately from alcohol from all other sources; in later analyses, the combined intake was used.

(French workers have observed different relationships of beer and other alcoholic beverages [Kaminski et al., 1976].) Mean intake of ethanol from beer at registration was 0.10 ounce per week, and from other alcoholic beverages, 0.06 ounce per week. At followup interview, this fell to 0.06 ounce per week from beer and 0.02 ounce from other sources. These are important indices of nutrition for a variety of reasons: the inclusion of alcohol abuse as a criterion for WIC eligibility in the initial WIC legislation; the potentially devastating effects on the fetus of heavy maternal alcohol use in early pregnancy; the interrelationship of alcohol with other nutrient intake and possible replacement of food calories by alcohol calories; the possible mediating effect of WIC benefits by counseling reduction of alcohol intake; and finally, the general state of uncertainty in our knowledge about the relationship of alcohol intake in mid-pregnancy to late pregnancy, in moderate or low doses, to fetal outcome. These results are therefore of great interest.

Reported alcohol intake in late pregnancy was significantly related to duration of gestation (1.48 days increase in gestation per ounce of weekly intake [$p < 0.01$]; alcohol intake at registration was not significantly related to duration of gestation). The relationship of alcohol intake to fetal growth was complex. A significant depression in birthweight was associated with reported amounts of ethanol taken at followup in the model with duration of gestation controlled (31 g less per ounce ethanol per week, $p < 0.05$). Since this late pregnancy intake was adjusted for intake early in pregnancy, the relationship to lower birthweight is with increased intake during pregnancy. The rate of birthweight under 2,501 g was significantly associated with reported alcohol intake at initial interview (1.3 percent increase with each ounce of ethanol, $p < 0.01$, with gestation controlled). Also, a nonsignificant decrease in newborn length was associated with alcohol intake in late pregnancy (0.15 cm shorter per ounce, $p = 0.06$).

The most provocative of the associations with alcohol was with depressed head circumference. Early pregnancy intake was unrelated to head circumference, but for each weekly ounce of total ethanol in late pregnancy, head circumference was depressed by 0.12 cm ($p = 0.03$). The effect of ethanol is specific to head growth: the relationship is still significant after control for infant length or birthweight. This is moderately convincing evidence of an association of late pregnancy alcohol intake with fetal growth retardation, with strongest effects on depressed head circumference.

No effect was found of enrollment in the WIC program on amount of alcohol consumption during pregnancy. However, the low reported intakes of alcohol from both WIC and control women probably reflect underreporting by study women, a common problem in most, if not all, dietary surveys. Thus, it is difficult to quantify the success (or failure) of the WIC program to induce change in alcohol consumption during pregnancy. Because of the potentially serious effect of alcohol on the fetus, however, the WIC program might well consider how to help women reduce alcohol intake during pregnancy.

Cigarette Smoking--The interrelationships among maternal smoking, maternal nutrition, and infant outcome continue to be of great interest. Smoking is related to various nutritional indices during pregnancy, and it is possible that the WIC program could affect fetal outcome among smokers either by counseling lowering cigarette use (no such effect was detected) or by compensating for the depression of maternal weight gain and other effects of smoking on birthweight.

In this study there were no significant relationships between smoking and duration of gestation. Although the relationship of smoking to gestation was weak, that with fetal growth was very strong. Among infants of women who smoked, use of a half a pack of cigarettes a day at registration was associated with decrease of 140 grams in birthweight, 0.8 centimeters in infant length, and 0.3 centimeters in head circumference. All of these were significant at levels of $p < 0.001$. Since smoking was strongly and significantly related negatively to maternal weight, weight gain, and triceps skinfold thicknesses at initial interview and followup, these relationships with maternal nutritional status may have mediated some of the effects of smoking on the fetus.

4. Conclusions

Fetal Mortality

The results of this study are consistent with reduced fetal mortality associated with enrollment in the WIC program, but the number of women in the final study sample was too small to test this issue adequately. Differences associated with the WIC program, while of reasonable magnitude, were not statistically significant.

Duration of Gestation

There is little evidence from this study of any general effect of WIC benefits on duration of gestation. There were, however, significantly reduced rates of preterm delivery among women with past history of low-birthweight delivery, a group at very high risk of adverse pregnancy outcome. There were relatively few such women in this study, and further research among similar women would be valuable.

Fetal Growth

Evidence of accelerated fetal growth was associated with WIC benefits, primarily on circumferential head growth. Relationships with either body mass (birthweight) or linear growth were not significant. The effects of WIC program participation and of duration of WIC benefits on infant head growth (independent of linear growth or growth in body mass) are parallel with the relationship of WIC benefits to head and linear growth among preschool children (see Chapter VI). Several important questions must be addressed: Why has this phenomenon not been observed previously, and what are the implications to later child somatic and behavioral growth and development?

While initial disparities in risk between the WIC and control groups may have accounted for the absence of an observed effect of the WIC program on birthweight, this is not a reasonable explanation for observed differential fetal growth: it is difficult to conceive of a mechanism for greater privilege or lower risk leading to smaller head size, relative to length or weight. Of course, all observations are possibly chance occurrences, but there is no obvious way in which bias or confounding could have led to accelerated head growth, relative to weight or linear growth, in the WIC group.

The effects of prenatal WIC benefits on infant head circumference, while statistically significant, were from 0.18 to 0.28 cm or about two-thirds to 1 percent of head size, a small magnitude that may have been missed in smaller past research studies. Also, most past studies of the effects of nutritional supplementation in pregnancy used birthweight as the only index of fetal growth and did not assess head size.

There is no way to predict whether the accelerated intrauterine head growth associated with prenatal WIC benefits will be associated with advantageous later somatic growth or behavior. While this question can be answered for these children only by a longitudinal study, such a study would not be straightforward. Given the advantageous social circumstances of control group children, relative to those whose mothers were enrolled in WIC, effects of WIC on cognitive and behavioral performance might be masked. While the sibling control study design employed by Hicks et al. (1982) overcomes these problems, the efficient and careful application of that design also is technically difficult: comparable behavioral indices are needed for children of different ages, and examiners should be kept blind to study status, which may be nearly impossible.

Birthweight

In the central study analysis, there was no relationship of WIC benefits to infant birthweight, which was unexpected. However, the results were not unequivocal. First, the study sample was considerably smaller than initially planned: it proved difficult to find control group pregnant women, and many of these control women later enrolled in WIC. Further, hospital delivery records were available for only 75 percent of the study population. Thus, the statistical power of this study to detect differences was much smaller than had been planned and may have been as low as one in four to detect an actual difference of 30 g. Second, an unknown number of control group women, probably about 25 percent, received WIC benefits after recruitment into the study. Third, the control group was more socially advantaged than the WIC study group and, while adjustment for these social factors did not greatly change the estimates of birthweight differences between the WIC and control groups, the possibility of under-adjustment of risk factors cannot be discounted.

Finally, the significant relationship between the State WIC program Directors' assessments of local WIC program quality and effectiveness with

birthweight did suggest program effect on birthweight. This finding prompts further questions: did the better programs affect birthweight by recruiting more appropriate women, those whose risk characteristics were such that nutritional supplementation was likely to be more effective? Were the effects mediated by better utilization of WIC nutritional supplements or by other interventions (better health care, for instance)? There was evidence that the effects may have been mediated by other than the simple provision of extra food. Program quality contributed less to differences on head circumference than on birthweight, so the effect of WIC on head growth was more likely a function of what was universal to the WIC program (i.e., the food package), while the birthweight effect depended very much on perceived program quality or on factors that would vary between programs, factors possibly above and beyond the provision of food.

Effect of Other Nutritional Factors on Perinatal Outcomes

Alcohol intake, especially in late pregnancy, was significantly related to fetal growth retardation, particularly reduced head growth. While the rate of growth of body mass (birthweight controlled for duration of gestation at delivery) was significantly depressed, the effects on depressed head growth were far greater: the relationship of depressed head growth to maternal alcohol intake was significant even after control for birthweight (or infant length). This differential depression of head growth could possibly have serious long-term consequences. Such infants, if a followup study is done, should be evaluated preferentially. This effect on head growth also suggests serious exploration of how the WIC program may better help women to reduce alcohol intake during pregnancy.

The two other nutritional factors associated with depressed head growth, observed above and beyond depressed birthweight and length, were cigarette smoking and low maternal weight gain early in pregnancy. The WIC program was effective in reversing the low average maternal weight gain of WIC recruits but had no demonstrable effect on maternal cigarette smoking.

VI. STUDY OF INFANTS AND CHILDREN

A. INTRODUCTION

1. Study Objectives

Most participants in the Special Supplemental Food Program for Women, Infants, and Children (WIC) program are infants under the age of 1 year and children between 1 and 5 years of age (see Volume I, Chapter I). These infants and children are determined to be at nutritional risk on the basis of hematological or anthropometric measures, documented medical conditions, or inadequate diets (see Volume I, Chapter I). The extent to which the WIC program affects the child's diet, growth, and health is therefore a major concern of the Study of Infants and Children.

The indices applied in this study to assess the impact of the WIC program are:

- Dietary intake, including:
  - nutrient intake.
  - food consumption patterns.
- Child growth, including:
  - weight.
  - height.
  - head circumference.
  - arm circumference and skinfold thickness.
- Use of preventive health services, including:
  - adequacy of immunization.
  - well child care.
- Child behavior, vocabulary, and memory.

These are the major outcome variables examined and reported in this chapter. The specific rationale for each measure is provided in the associated subsection.

The study is cross-sectional, assessing the effects of the WIC program on the children of women included in the Longitudinal Study of Pregnant Women. These children may or may not have been WIC recipients (currently or in the past), independent of their mother's status relative to program participation. The study sample included 2,370 children.

For each of these children a series of questions was asked of the mother concerning the child's health, and a 24-Hour Dietary Recall was administered to the mother concerning the child's food intake in the previous 24 hours. A battery of psychological tests and anthropometric measurements were conducted on the child, usually in the child's home.

2. Identifying Appropriate Controls

Most beneficiaries of the WIC program are infants and children under the age of 5, yet much less is known about WIC's effects on their health and well being than on the pregnant woman. The reasons are not obscure. First, pregnancy lasts months, rather than years, and the effects of intervention can be studied relatively promptly. Next, several indices of pregnancy outcome are unequivocally and universally considered important, are measured relatively easily, and allow program effectiveness to be judged. Finally, there is a long tradition (as well as a legal obligation) of collecting routine information on the status of the newborn, and it is an efficient research strategy to exploit such otherwise available data if they are of reasonable quality. Not as obvious, but very important, are the existing, accessible sampling frames for recruiting pregnant women into research studies: most pregnant women seek health care relatively early in pregnancy, facilitating the study of both recipients of some intervention such as WIC and comparable control groups.

None of these conditions hold for the preschool child. Change cannot be meaningfully evaluated other than for a few issues (e.g., replenishment of iron stores) over a time span as short as a few months. There is no clear or universal consensus on appropriate criteria for program success or on indices reflecting these criteria. Once agreed upon, the indices are difficult to measure. There are no large-scale preexisting data resources, other than death certification (and change in death rate is a poor index of program effect because death is very infrequent and in all likelihood not appreciably affected by the program, at least after early infancy). Finally, and of great importance, it is very difficult to recruit a truly comparable control group. For example, of the 14 studies reviewed on the WIC program's effects on hematologic indices, only 1 study of infants (there were none for children) was controlled, and the same study was the only 1 of 13 of childhood physical growth that was controlled (Paige, 1983). (See Chapter II, Volume II.)

Several alternatives to find appropriate control children were considered but found to be flawed. For instance, control preschool children might have been children at health department well-child clinics or possibly at hospital pediatric clinics or emergency rooms. However, well-child clinics supply regular preventive health care, one of WIC's program goals. There would thus be severe bias against the WIC program in any comparison of immunization rates or other use of preventive services. On the other hand, children would go to emergency rooms or hospital clinics because they were sick. Any comparison between their health and that of WIC recipients would thus also be systematically flawed. Such children would be sicker, less likely to be well grown, and less likely to have used preventive services, independent of any WIC program effects.

The problem of finding controls who were free of bias associated with some institutional affiliation was solved by studying the preschool children of the representative sample of women recruited into the Longitudinal Study of Pregnant Women. This strategy slightly truncated the age distribution of the study sample of children (very young infants and last born children were underrepresented) but introduced no other obvious special bias. The mother's early pregnancy was unlikely to have any but minimal effects on the indices under study among children. It was required that the child's 24-Hour Dietary Recall refer at latest to the day after her recruitment into WIC to ensure that the mother's enrollment in WIC did not affect the child's dietary intake. (The vast majority of recalls actually refer to the day prior to her recruitment.) Thus, the mother's WIC food should not affect the child's reported dietary intake. Similarly, the first few days of the mother's benefits would not appreciably affect the child's anthropometric or psychological assessments, which were done within 48 hours after the mother's recruitment. While the representativeness of the sample of children necessarily reflected the truncation of the sample of pregnant women (no Indian WIC agencies were included, nor were WIC recipients from the smallest 6 percent of WIC agencies), the strategy used has several important benefits.

Not only were current WIC recipients studied, but an equally large number of children were available who had been WIC recipients in the past but who were no longer receiving benefits. If the study sample had been limited to children who were current WIC recipients, the results would have been subject to two additional sources of bias. The noncompliant and the uncooperative, who would tend to have worse outcomes than those who cooperated with the program, over and above any program effects, would be excluded. Their exclusion could bias the results to overestimate WIC program effects. On the other hand, with the scarcity of places in the WIC program for children, children doing well might have been selectively not recertified by the local agency, leaving a balance of children defined as more in need of further benefits. The exclusion of successful children might yield falsely low estimates of program effects. With the sampling strategy used, not only could the departure rate from the WIC program be estimated, but also the current status of these former WIC recipients could be assessed.

In general, because controls were more privileged (see Chapter IV), estimates of program effect would tend to be conservative. There is an additional test of whether the social disparity between WIC recipients (both past and present) and controls affects estimates of program effect. Results are adjusted first only for the child's age and sex and then also for a wide array of the family's social and demographic characteristics. If adjustment of these social and demographic characteristics produces little change in the estimated relationship of the program to outcome, such differences may be related only minimally to the particular outcome under study and estimates of program effect are unlikely to be a function of noncomparability of WIC recipients and controls. However, if major shifts follow adjustment, whether positively or negatively, results must be interpreted far more cautiously than with minimal changes. This is the case for analysis of the relationship of WIC to both health care and psychological status among preschoolers.

B. DIETARY INTAKE

1. Introduction

Presently, supplemental foods, as defined by PL 95-627, Section 17(b)-(14), enacted November 10, 1978, are foods containing nutrients determined by nutrition researchers to be lacking in the diets of pregnant, breast-feeding, and postpartum women; infants; and children. Previous legislation had specified these nutrients as high-quality protein, iron, calcium, Vitamin C, and Vitamin A. 24-Hour Dietary Recalls were used to assess the nutrient intake of study infants and children.* The hypothesis is that consumption of the foods provided by the WIC program, in conjunction with nutrition education, should be reflected in improved intake of the target nutrients.

Nutrient Database

The primary database for the quantitative estimation of nutrient intake was the USDA Nutrient Data Base for Individual Food Intake Surveys (Release 1, 1980), also used in the Longitudinal Study of Pregnant Women. This database provides estimates of the content of 15 nutrients for approximately 4,500 different foods. The nutrients are calories, protein, fat, carbohydrate, calcium, iron, magnesium, phosphorus, Vitamin A, thiamin, riboflavin, niacin, Vitamin B_6, Vitamin B_{12}, and Vitamin C. No distinction is made between animal and other protein or between saturated and unsaturated fats. Sodium, folate, zinc, and copper are not included. (The latter three nutrients have been implicated at times as important to fetal growth; sodium mainly relates to the origins in childhood of chronic adult cardiovascular disease.)

Cereals are major constituents of the foods supplied to WIC recipients. Therefore, the database was supplemented from the Revised Agriculture Handbook 8-8 (USDA 1982a) to provide the best estimate of the nutrient content of specific cereals. Additional information from food manufacturers and other nutrient databases was also used to supplement the database (see Volume IV, Appendix VI-A).

Research Definition of WIC Foods

WIC foods were specified in the nutrient database to assess consumption of foods potentially available as WIC food supplements. Definitions of potential WIC foods were obtained from the official program regulations (Federal Register, November 12, 1983), from supplemental lists of cereals published by the WIC program, and from personal communication with Federal WIC personnel. Specific foods designated WIC foods are listed in Appendix VI-A.

---

*If more than one biological child under 5 years of age was living at home, one was randomly chosen as the study (index) subject.

While WIC regulations specify different supplemental food packages for children of different ages (0 to 3 months old, 4 to 12 months old, and 1 to 4 years old, see Chapter I), one list of WIC foods was prepared for this study for children of all ages. Thus, peanut butter consumed by a child under 1 year of age would be identified in these analyses as a WIC food, although not available from the WIC program. However, because the study design included only children of pregnant women, few infants were 0 to 3 months old (n = 6) and only 14 percent of study children were under 1 year of age. It was assumed that baby foods and infant formula, available from the WIC program for infants 4 to 12 months of age, would only rarely be eaten by older children and thus would be unlikely to distort results for older children. The effect on analyses of intake by infants of foods designated WIC foods for older children, at least dairy foods, should be minimal because infants enrolled in the WIC program were consuming formula rather than milk (see below).

WIC infant formulas were defined in analysis as those that met the program requirement of 10 mg of iron per liter of formula. Other formulas are allowed by the program only with a physician's prescription; these were not designated WIC foods. Infant cereals provided by WIC must contain a minimum of 45 mg of iron per 100 g of dry cereal. Cereal-fruit combinations are not allowed.

Cereals were assumed to be available from the WIC program if they were so identified by WIC program staff in the Washington, D.C., Office of the Food and Nutrition Service (FNS). Dried beans and peas, peanut butter, milk, cheese, and eggs were included as WIC foods, as specified in the WIC regulations.

To qualify as WIC foods, juices have to contain a minimum of 30 mg of vitamin C per 100 mL. Juice drinks are not allowed. Orange and grapefruit juices do not require fortification to meet this requirement, nor does combined orange-grapefruit juice. Apple juice, grape juice, and pineapple juice require fortification. State WIC programs generally specify allowed brands of fortified juices to WIC recipients and vendors. Because fortification information or brand names were not available from dietary recalls, juices requiring fortification were not considered WIC foods in this analysis. All infant juices are allowed for infants 4 to 12 months of age. These were therefore considered WIC foods.

Foods prepared at home were considered WIC foods only if the predominant components were available in WIC food packages. For example, macaroni and cheese was excluded, while refried beans and scrambled eggs were included. For several analyses, foods potentially available from the WIC program were further categorized as dairy foods, cereals, juices, or other foods.

2. Analytic Methods

The mean intake of current enrollees in the WIC program was compared with that of past WIC recipients and with that of children who had never

been in the WIC program at any time since birth (control group). The number of subjects in each group was 711, 637, and 763, respectively. Very few children were currently or previously enrolled in WIC whose mothers were not in the sample of new WIC recipients in early pregnancy, but the converse was not true: more than half the control children were children of mothers enrolled in WIC. The families of control children whose mothers were enrolled in WIC were more privileged than those of WIC children (see Chapter IV). The child's enrollment was more strongly associated with lower social status than that of the mother, possibly reflecting the lower priority for WIC benefits of children than of pregnant women.

The central analyses of this study relate dietary intake to current WIC receipt, assuming dietary intake reflected current more than past benefits. Residual effects of past WIC enrollment on current intake were also tested.

Twenty-Four Hour Dietary Recalls were performed for 2,291 children. One child was randomly chosen if the mother had more than one child under age 5 living at home. Children were excluded from the current analyses if they were currently breastfed (n = 7), if their dietary recall was only partially completed (n = 121), if they were on a special diet (n = 68) (see Volume IV, Appendix VI-A, for types of special diet; special diets were about equally represented in the current WIC [n = 20] past WIC [n = 17], and non-WIC [n = 30] groups), or if they were reported to have consumed amounts of a food exceeding a maximum defined range and these recalls were therefore suspect (i.e., likely recording error, etc., n = 14). Recalls for several other children were excluded because they had passed their fifth birthdays at the time of exam, and recalls should not have been performed. The analyses presented are based on recalls for 2,111 children.

Multiple linear regression analysis was used to evaluate the effect of the WIC program on dietary intake. The dependent variables were:

- Mean daily nutrient intake.
- Mean daily nutrient intake from foods potentially available from WIC (both total amounts and also subdivided by food group).
- Mean daily nutrient intake adjusted for caloric intake (equivalent to nutrient density).
- Proportion of children with diets below 77 percent of the Recommended Daily Allowance (RDA) for all nutrients except energy, for which the level was 100 percent of the Recommended Energy Intake. (No RDAs exist for carbohydrate and fat.)

For infants, mean nutrient intake was partitioned into that derived from formula, from other WIC foods, from milk, or from all other foods. All of these outcomes are presented separately for infants and children. Mean intake and intake rate under 77 percent of the RDA (100 percent for energy) were also stratified by single year of age.

Two regression models were used for each dependent variable. One model controlled only for age and sex (a second-order term for age was included to account for nonlinearity of the relationship of age to outcome). The second regression model included a large array of covariates to adjust for possible important differences in characteristics across study groups that might influence nutrient intake. The covariates were:

- Child's age.
- Age squared.
- Sex.
- Height.
- Ethnicity.
- Current participation in a school or preschool food program.
- Household size.
- Mother's age and number of years of education.
- Father figure living in the household.
- Number of years of father's education.
- Regular occupations of both parents and whether they were working.
- Whether the family was receiving Aid to Families of Dependent Children (AFDC), Medicaid, or Food Stamps.
- Whether the intake during the 24-hour period of the recall was considered unusual by the mother.

(See Table VI-1 for specification of covariates.) All reported results are from the fully adjusted models, unless otherwise specified.

Variables describing factors other than food supplements that might mediate the effects of the WIC program, such as quality and extent of nutrition education, could not be included in analyses. In the Longitudinal Study of Pregnant Women, WIC program characteristics that might mediate some of WIC's effect on nutrient intake were specified from questionnaires completed by program administrators; but in the Study of Children, because there were no constraints on the specific WIC program in which the child had been or was enrolled, program characteristics could not be specified and used in analyses. The child's height was included as a covariate that could affect dietary intake. The child's weight was explicitly excluded as a covariate: inclusion could only be justified if heavier children should eat more and thinner children less.

Table VI-1

Definitions and Units for Covariates in Regression Analyses; Unless Noted, Used for All Dependent Variables

Variable name	Omitted from	Variable definition and units
KIDAGE		Child's age (months)
AGESQ		Child's age squared (months)
SEX		Female = 1, Male = 0
CATETH1	3	Hispanic = 1, Others = 0
CATETH2	3	Black = 1, Others = 0
CATETH3	3	Other = 1, Others = 0
INCOME		Income (dollars/100)
CATINC4		Income missing = 1, Not missing = 0
HHSIZE		Household size (n)
MOMAGE		Mother's age (years)
MOMED		Mother's education (years)
FATED		Father's education (years)
CATFED3		Father's education missing = 1, Not missing = 0
CATMOCC1		Mother working on farm = 1, other = 0
CATMOCC2		Mother working in sales, skilled trade, clerical = 1, Others = 0
CATMOCC3		Mother working as professional = 1, Others = 0
CATMOCC4		Mother never worked = 1, Others = 0
CATFOCC1		Father working on farm, Others = 0
CATFOCC2		Father working in sales, skilled trade, clerical = 1, Others = 0
CATFOCC3		Father working as professional = 1, Others = 0
CATFOCC4		Father never worked = 1, Others = 0
MARITAL		Mother married = 1, Others = 0
LIVWFAT		Father figure in home = 1, No = 0
CATMEMP1		Mother employed = 1, Others = 0
CATMEMP2		Mother unemployed = 1, Others = 0
CATFEMP1		Father employed = 1, Others = 0
CATFEMP2		Father retired, in jail, deceased = 1, Others = 0
AFDC		Mother of AFDC = 1, Others = 0
MEDICAID		Mother of Medicaid = 1, Others = 0
CATFDST		Mother on Food Stamps = 1, Others = 0
SCHFOOD		Current participation in School Food Program = 1, Others = 0
USUAL	2, 3, 5	Yesterday's diet not usual = 1, Usual = 0
HEIGHT		Child's height (cm)
MISKIDHT	2, 3, 5	Child's height missing = 1, Not missing = 0
BRTORDER	1, 5	Child's birth order
TWIN	1, 5	Child is twin = 1, Others = 0
MOMHT	1, 3, 5	Mother's height (inches)
DADHT	1, 3, 5	Father's height (inches)
DADHTMIS	1, 3, 5	Father's height missing = 1, Not missing = 0
MATBEVR	1, 2, 4, 5	Maternal behavior scale (See Psychology Text)
MISBEVR	1, 2, 4, 5	Maternal behavior missing = 1, Not missing = 0
CATRACE1	1, 2, 5	Black = 1, Others = 0
CATRACE2	1, 2, 5	Asians, American Indian unknown = 1, Others = 0
CATLANG1	1, 2, 5	Spanish = 1, Others = 0
CATLANG2	2, 2, 5	Other language, Not English, Others = 0

1 Dietary.
2 Anthropometry.
3 Psychology, all.
4 Psychology, behavioral measures only.
5 Health.

In addition to mean nutrient intake, another index of nutritional adequacy used was the proportion of children consuming less than the Recommended Energy Intake, or less than 77 percent of the RDA for all other nutrients.* Seventy-seven percent of the RDA, taken over the long term, approximates the nutrient requirements of 50 percent of the population (Anderson et al., 1982). These same standards have been used in many past studies, including the previous WIC evaluation of Edozien et al. (1976a,b, 1979).

The intakes of component food groups available in WIC food packages were compared to understand the origins of the differences in nutrient intake between WIC and control children. Potential WIC foods were divided into four component groups: dairy foods (including formula), cereals, juices, and other WIC foods (including eggs, peanut butter, and dried beans and peas).

WIC food benefits are likely to be more important for some children than for others (e.g., poorer, shorter, or thinner children), and WIC program enrollment may be more successful for some children than others. The study population was stratified by several key risk factors to study these issues. For analyses of total mean daily nutrient intake, nutrient intake from foods potentially available from WIC food packages, and nutrient intake controlled for caloric intake, the relationship of dietary intake and WIC participation was stratified by:

- Child's age, body mass index (Quetelet's index, a measure of relative fatness or obesity), height, ethnicity, and sex.
- Mother's age, years of education, and marital status.
- Father figure in the home.
- Receipt of AFDC and Food Stamps.
- Number of people in the household.
- Annual household income.
- Maternal marital status and family size studied simultaneously.

---

*The RDAs were extrapolated for each month of age because it was assumed that requirements are continuous with age and do not change abruptly at age 1 or 4. For example, the RDA for Vitamin A is 2,000 international units (IU) for 1- to 3-year-olds and 2,500 IU for 4- to 6-year-olds. Thus, at the fourth birthday, the child's RDA for Vitamin A increases by 500 IU. The RDA for each age range was assumed to be appropriate for children of the mean age of the range. Therefore, 2,000 IU was set as the RDA for Vitamin A for children 2.5 years of age and 5.5 years of age, respectively. Extrapolating sets the RDA for 4-year-olds at 2,250 IU.

For analyses of the frequency of those consuming less than 77 percent of the RDA for specific nutrients (100 percent of the Recommended Energy Intake), stratification was by child's age, sex, and ethnicity and by family receipt of AFDC and Food Stamps.

3. Results

Results of the dietary analysis, with minor exceptions, suggest that current WIC benefits are improving the quality of diet among preschool children consistent with program goals and that these improvements are mediated by foods supplied by the WIC package. The improvements are limited to those currently enrolled, with little or no carryover from past program participation.

The results of the analysis of dietary intake are presented in the five following subsections. They include a discussion of mean nutrient intake of specific nutrients; an examination of proportions of children with nutrient consumption less than 77 percent of the RDA; food groups constituting the WIC package; intake of formula vs. whole milk in infancy; and nutrient intake stratified by important characteristics of mothers, infants, children, and families.

Mean Nutrient Intake

The results of regression analyses on mean intake are presented for each nutrient in Table VI-2 for infants and for children.* Three analyses are presented. First is the total reported intake for the past 24 hours adjusted for the entire set of covariates. Second, the nutrient intake from foods potentially available from WIC food packages (those listed in Appendix VI-A) are presented. The third analysis is for 24-hour intake adjusted for caloric intake, so differences across study groups are equivalent to differences in the nutrient density of the diet (i.e., nutrients per calorie). For each analysis, results are presented with the mean for the control group. The values for current WIC and past WIC recipients are presented as changes from the control group mean.

The relationship of WIC to specific nutrient intake falls naturally into three categories:

- Nutrients for which intake was significantly improved by current WIC benefits.
- Nutrients with lower mean intake among current WIC recipients.
- Nutrients unrelated to WIC benefits.

---

*Specimen regression analyses for energy and iron are presented in Volume IV, Appendix VI-B. The full set of results adjusted for age and sex and adjusted for all covariates is also included in Appendix VI-B.

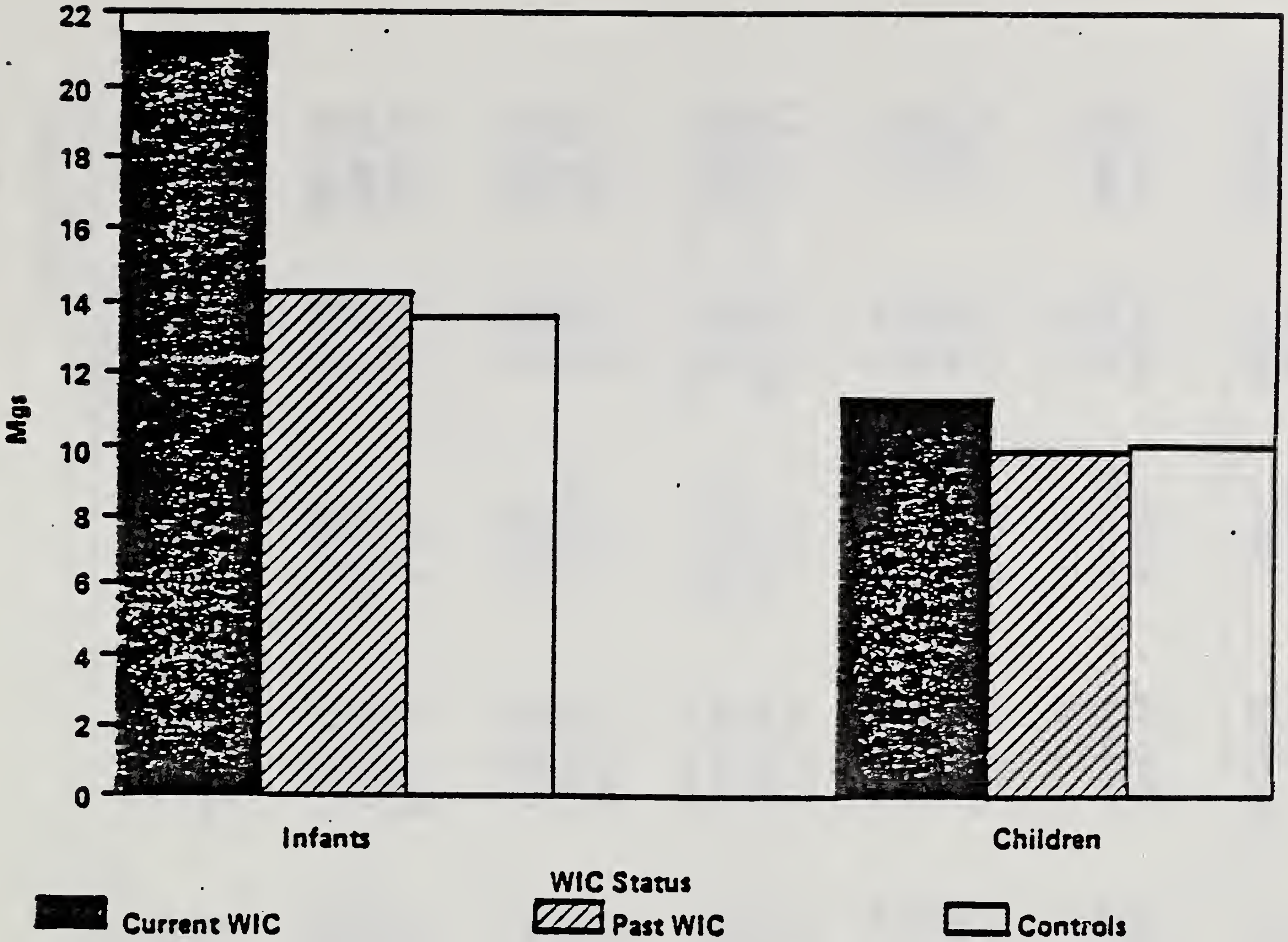


Figure VI-1. Mean intake of iron (mg) for infants and children.

Nutrients with Increased Intake Associated with Current WIC Enrollment

Iron--The contribution of iron to the diet by the WIC program was significant for both infants and children, but the magnitude was far greater for infants, as shown in Figure VI-1 (for infants, 21.4 mg vs. 13.5 mg among controls, $p < 0.01$; for children, 11.1 mg vs. 9.9 mg, $p < 0.01$). The differences between current WIC recipients and others were contributed by foods potentially available from WIC, both for infants and children.

Vitamin C--The mean intakes of control infants and children were similar (86 and 92 mg, respectively; see Table VI-2). The increment contributed by current WIC benefits was more than double among infants compared to children (27 mg among infants vs. controls, $p < 0.01$; 12 mg among children vs. controls, $p < 0.05$). The difference in intake of Vitamin C between current recipients and controls was contributed by foods potentially available from WIC, both for infants and children.

Thiamin--The daily thiamin intake of control infants and children was similar (0.85 mg and 1.01 mg, respectively), and the increment in intake

Table VI-2

Total Mean Dietary Intake, Mean Dietary Intake from Potential WIC Foods, and Total Mean Dietary Intake Adjusted for Caloric Intake for Infants and Children by Current and Past Receipt of WIC[a]

	Infants			Children		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Calories (kcal)						
Total	23.16	71.52	895.78	4.91	-6.93	1167.78
From potential WIC foods	82.85**	15.55	487.61	36.82**	5.22	348.24
Protein (g)						
Total	-5.37**	3.83	33.13	-0.06	-0.21	42.70
From potential WIC foods	-4.46**	1.54	22.14	0.28	0.17	18.13
Total adjusted for caloric intake	-6.11**	1.54	33.83	-0.23	0.03	42.67
Fat (g)						
Total	2.17	0.09	35.54	0.03	-0.15	43.43
From potential WIC foods	4.27*	-0.56	23.45	0.47	0.17	16.86
Total adjusted for caloric intake	1.26	-2.73	36.40	-0.17	0.13	43.39
Carbohydrates (g)						
Total	-2.95	14.19	109.40	1.32	-0.23	155.12
From potential WIC foods	7.05*	4.09	43.96	7.69**	0.73	31.93
Total adjusted for caloric intake	-5.80	5.41	112.07	0.69	0.66	155.01
Calcium (mg)						
Total	-223.78**	5.02	856.47	9.63	11.40	683.59
From potential WIC foods	-222.00**	-0.19	754.16	15.03	15.23	485.93
Total adjusted for caloric intake	-236.36**	-33.83	868.31	7.18	14.85	683.16
Iron (mg)						
Total	7.85**	0.77	13.52	1.24**	-0.12	9.86
From potential WIC foods	8.05**	0.98	9.18	2.24**	0.07	2.97
Total adjusted for caloric intake	7.48**	-0.36	13.87	1.20**	-0.07	9.86

See footnotes at end of table.

(continued)

Table VI-2 (continued)

	Infants			Children		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Magnesium (mg)						
Total	-23.35**	16.68	146.76	0.95	-1.77	166.72
From potential WIC foods	-17.17**	11.58	95.36	4.69	0.18	74.22
Total adjusted for caloric intake	-26.40**	7.26	149.63	0.30	-0.86	166.61
Phosphorus (mg)						
Total	-197.02**	71.31	772.41	-1.23	0.93	815.27
From potential WIC foods	-183.98**	44.67	599.94	13.27	8.68	447.58
Total adjusted for caloric intake	-210.56**	29.49	785.16	-4.36	5.35	814.72
Vitamin A (IU)						
Total	-19.20	2461.47*	3,948.05	486.34	357.43	3,624.17
From potential WIC foods	499.22**	138.56	1,217.90	470.65**	78.52	973.05
Total adjusted for caloric intake	-98.25	2217.28*	4,022.49	472.91	376.36	3,621.80
Thiamin (mg)						
Total	0.06	0.06	0.85	0.08*	0.00	1.01
From potential WIC foods	0.11*	0.08	0.53	0.15**	0.02	0.33
Total adjusted for caloric intake	0.04	0.00	0.87	0.07**	0.01	1.01
Riboflavin (mg)						
Total	-0.18	0.15	1.56	0.08	0.06	1.51
From potential WIC foods	-0.14	0.06	1.18	0.16**	0.04	0.77
Total adjusted for caloric intake	-0.21*	0.06	1.59	0.07	0.07	1.51
Niacin (mg)						
Total	1.03	1.54	8.09	0.94*	-0.07	11.40
From potential WIC foods	1.90**	1.26	3.74	1.89**	0.19	2.13
Total adjusted for caloric intake	0.84	0.96	8.26	0.90*	-0.01	11.39

See footnotes at end of table.

(continued)

Table VI-2 (continued)

	Infants			Children		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Vitamin B_6 (mg)						
Total	0.05	0.22*	0.66	0.10*	0.02	1.09
From potential WIC foods	0.05	0.09	0.33	0.19**	0.03	0.32
Total adjusted for caloric intake	0.03	0.16*	0.68	0.09*	0.02	1.09
Vitamin B_{12} (μg)						
Total	0.08	2.93*	2.48	0.39	0.42	3.34
From potential WIC foods	-0.47**	0.23	2.25	0.52**	0.12	1.89
Total adjusted for caloric intake	0.03	2.75*	2.54	0.38	0.44	3.34
Vitamin C (mg)						
Total	27.40**	12.84	85.72	11.85*	-3.36	92.07
From potential WIC foods	34.36**	3.11	40.47	15.83**	0.26	36.94
Total adjusted for caloric intake	25.28*	6.28	87.72	11.58*	-2.98	92.02
n	178	32	84	533	605	679

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

associated with current WIC enrollment was also similar for infants and children (0.06 mg in infants, [n.s.]; 0.08 mg in children, $p < 0.05$). In both cases, the contribution was by foods potentially available from WIC. WIC benefits were not statistically associated with a decrease in the rate of low intake for children or infants.

Riboflavin--Intake from WIC foods was considerably higher among current WIC children than among controls (0.93 mg vs. 0.77 mg, $p < 0.01$) but not among infants currently receiving WIC compared to controls.

Niacin--The increment in daily niacin intake associated with current enrollment in WIC was 0.9 mg for children ($p < 0.05$) and 0.84 for infants (n.s.). The amount of niacin from WIC foods was significantly higher in WIC participants than in controls for both infants and children.

Vitamin B_6--Children who were WIC participants consumed 1.19 mg of Vitamin B_6 a day compared to 1.09 mg among controls ($p < 0.05$). Nutrient density was also significantly higher.

Among infants, those currently enrolled in the WIC program did not have significantly increased mean intake compared to controls, but past WIC recipient infants had significantly higher mean intake and intake controlled for calories. There were few such infants, however ($n = 32$).

Vitamin A--Among infants, the mean intake of Vitamin A by past WIC recipients was significantly greater than among controls ($p < 0.05$) (see Table VI-2). However, even though mean intakes were not significantly different, the proportion of current WIC recipients with low Vitamin A intake was significantly lower than among controls for both infants (9.8 percent vs. 21.0 percent among controls, $p < 0.05$) and for children (21.3 percent vs. 27.2 percent among controls, $p < 0.05$).

Nutrients with Decreased Intake among Current WIC Recipients

Calcium, phosphorus, and magnesium--The mean intakes of these three nutrients among WIC infants, but not among children, were significantly lower than among controls. Among children, intake of these nutrients was essentially independent of WIC enrollment.

The origin of these differences among infants is straightforward and explored below: infants in the WIC program were given formula almost exclusively, rather than whole milk, and the concentration of these three nutrients is lower in formula than in milk.

Protein--Statistically significant differences were limited to decreases in protein intakes in infants (27.8 g among current WIC recipients vs. 33.1 g intake among controls, $p < 0.01$). This difference, like that for calcium, phosphorus, and magnesium, reflects the greater use of formula and lower dependence on milk, by infants enrolled in WIC.

Nutrients with Minimal Relationship to WIC Benefits

Calories--The caloric intake of infants currently enrolled in WIC was 23 calories more than that of controls (n.s.) and 5 calories more than that of children (n.s.). Among infants, the increment of caloric intake from WIC foods was 83 kcal more than controls, $p < 0.01$, over twice that among children (37 kcal more than controls, $p < 0.01$).

Fat--The overall fat intake of WIC recipients was nearly identical to that of controls.

Carbohydrate--Overall carbohydrate intake was not significantly associated with WIC participation.

Vitamin B_{12}--While overall intake was modestly higher among WIC children than among controls (0.25 µg), this difference was not statistically significant.

Comparison of Nutrient Consumption with the RDA (100 percent for the Recommended Energy Intake)

The estimated mean intakes of control group children described above are very similar to the mean intakes reported by the USDA Nationwide Food Consumption Survey (1977-78) for children of comparable age (see Volume IV, Appendix VI-B).* The major exception is Vitamin C. The average daily Vitamin C intake in the USDA Survey for children between ages 1 and 5 was about 70 mg, while the controls in this study report consuming 92 mg daily.

While the intakes of controls were thus concordant with past survey data, these empirical data bear only moderate relationship to the RDA, as shown in Table VI-3. A good example is iron. The mean intake of control children is a little less than 10 mg, which, while low relative to the RDA (15 mg for children 12 to 47 months of age), is almost the same as that found in the past USDA Survey for children of comparable age (8 mg for 1- to 2-year-olds and 10 mg for 3- to 5-year-olds).

While the mean intake of protein, Vitamin A, riboflavin, Vitamin B_{12} and Vitamin C by control children exceeds the RDAs for 1- to 3-year-olds by 50 percent, the intakes are very similar to those of children in the USDA Nationwide Food Consumption Survey. For example, the mean protein intake of children in the USDA Survey was 46.1 g at ages 1 and 2 and 55.1 g at ages 3 to 5, both exceeding the mean of 42.7 g in the control children. Vitamin A intake of control children was 3,624 IU, which was comparable to

---

*After careful consideration, it was decided not to use the USDA Food Consumption Survey for Low-Income Households (1980) as the standard of comparison for this study, but rather the USDA Food Consumption Surveys (1977-78) for all income levels. There are two reasons. The results for the low-income population are likely to have been influenced by the WIC program with consequent risk of underestimating program effects. Low-income children were consuming more calories, but nutrient densities of their diets did not differ systematically from those of all children (see Volume IV, Appendix VI-B).

Table VI-3

Mean Dietary Intakes Estimated by Regression Analyses, Presented as Percentages of the RDAs by Current and Past Receipt of WIC Benefits

	Infants						
		Current WIC		Past WIC		Controls	
Nutrient	RDA[a]	Mean	% RDA	Mean	% RDA	Mean	% RDA
Energy (kcal)	945.0	918.94	97	967.30	102	895.78	95
Protein (g)	18.0	27.76	154	36.95	205	33.13	184
Calcium (mg)	540.0	632.65	117	861.45	160	856.43	159
Iron (mg)	15.0	21.37	142	14.29	95	13.52	90
Magnesium (mg)	70.0	123.43	176	163.46	234	146.78	210
Phosphorus (mg)	360.0	665.39	185	843.72	234	772.41	215
Vitamin A (IU)	2,000.0	3,928.85	196	6,409.52	320	3,948.05	197
Thiamin (mg)	0.5	0.91	182	0.91	182	0.85	170
Riboflavin (mg)	0.6	1.38	230	1.71	285	1.56	260
Niacin (mg)	0.8	9.12	1,140	9.63	1,204	8.09	1,011
Vitamin B_6 (mg)	0.6	0.71	118	0.88	147	0.66	110
Vitamin B_{12} (μg)	1.5	2.56	171	5.41	361	2.48	165
Vitamin C (mg)	35.0	113.12	323	98.56	282	85.72	245

	Children						
		Current WIC		Past WIC		Controls	
Nutrient	RDA[b]	Mean	RDA	Mean	RDA	Mean	RDA
Energy (kcal)	1,300.0	1,172.69	90	1,160.85	89	1,167.78	90
Protein (g)	23.0	42.64	185	42.49	185	42.70	186
Calcium (mg)	800.0	693.22	87	694.99	87	683.59	85
Iron (mg)	15.0	11.10	74	9.74	65	9.86	66
Magnesium (mg)	150.0	167.67	112	164.95	110	166.72	111
Phosphorus (mg)	800.0	814.04	102	816.30	102	815.37	102
Vitamin A (IU)	2,000.0	4,110.46	206	3,981.55	199	3,624.12	181
Thiamin (mg)	0.7	1.09	156	1.01	144	1.01	144
Riboflavin (mg)	0.8	1.59	199	1.57	196	1.51	189
Niacin (mg)	9.0	12.34	137	11.37	126	11.42	127
Vitamin B_6 (mg)	0.9	1.19	132	1.11	123	1.09	121
Vitamin B_{12} (μg)	2.0	3.73	187	3.76	188	3.34	167
Vitamin C (mg)	45.0	103.92	231	88.71	197	92.07	205

[a]RDA applicable to infants 6 to 11 months of age.

[b]RDA applicable to children 12 to 47 months of age.

the mean intake of 3,694 IU in 3- to 5-year-olds and greater than the mean intake of 1- and 2-year-olds in the USDA Survey. Control children consumed 1.51 mg of riboflavin and 3.34 μg of Vitamin B_{12}. One- and 2-year-olds in the USDA Survey consumed slightly less (1.43 mg and 3.04 μg, respectively), but 3- to 5-year-olds consumed slightly more (1.57 mg and 3.68 μg, respectively). Figure VI-2 illustrates the mean daily nutrient intake of the targeted WIC nutrients, protein, iron, calcium, Vitamin A, and Vitamin C from Table VI-3 for current and past WIC recipients and controls, respectively.

Relative to the RDAs, the patterns were somewhat different for infants and older children. Table VI-4 shows the percent of infants and children with nutrient consumption less than 77 percent of the RDA (100 percent for the recommended energy intake). Seventy percent of control and past WIC

Table VI-4

Proportion of Infants and Children with Mean Nutrient Intake Less than 77 percent of RDA (100 percent for Energy) by Current and Past Receipt of WIC[a]

	Infants			Children		
Nutrients	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Calories (kcal)	-0.070	-0.116	0.579	-0.009	0.002	0.645
Protein (g)	-0.008	0.030	0.046	0.005	-0.010	0.068
Calcium (mg)	0.103*	0.071	0.103	-0.023	0.011	0.439
Iron (mg)	-0.287**	0.100	0.544	-0.103**	-0.009	0.726
Magnesium (mg)	0.043	0.004	0.021	-0.005	0.004	0.243
Phosphorus (mg)	0.013	-0.008	0.075	-0.022	-0.019	0.259
Vitamin A (IU)	-0.112*	0.038	0.210	-0.059*	-0.012	0.272
Thiamin (mg)	-0.029	0.047	0.064	0.004	-0.015	0.129
Riboflavin (mg)	-0.011	-0.042	0.042	-0.039*	-0.025	0.115
Niacin (mg)	-0.076	-0.031	0.382	-0.038	0.018	0.306
Vitamin B_6 (mg)	0.104*	0.022	0.146	-0.052*	-0.027	0.337
Vitamin B_{12} (μg)	-0.035	0.008	0.139	-0.040	-0.030	0.226
Vitamin C (mg)	-0.105*	-0.002	0.196	-0.045	0.007	0.266
n	178	32	84	533	605	679

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

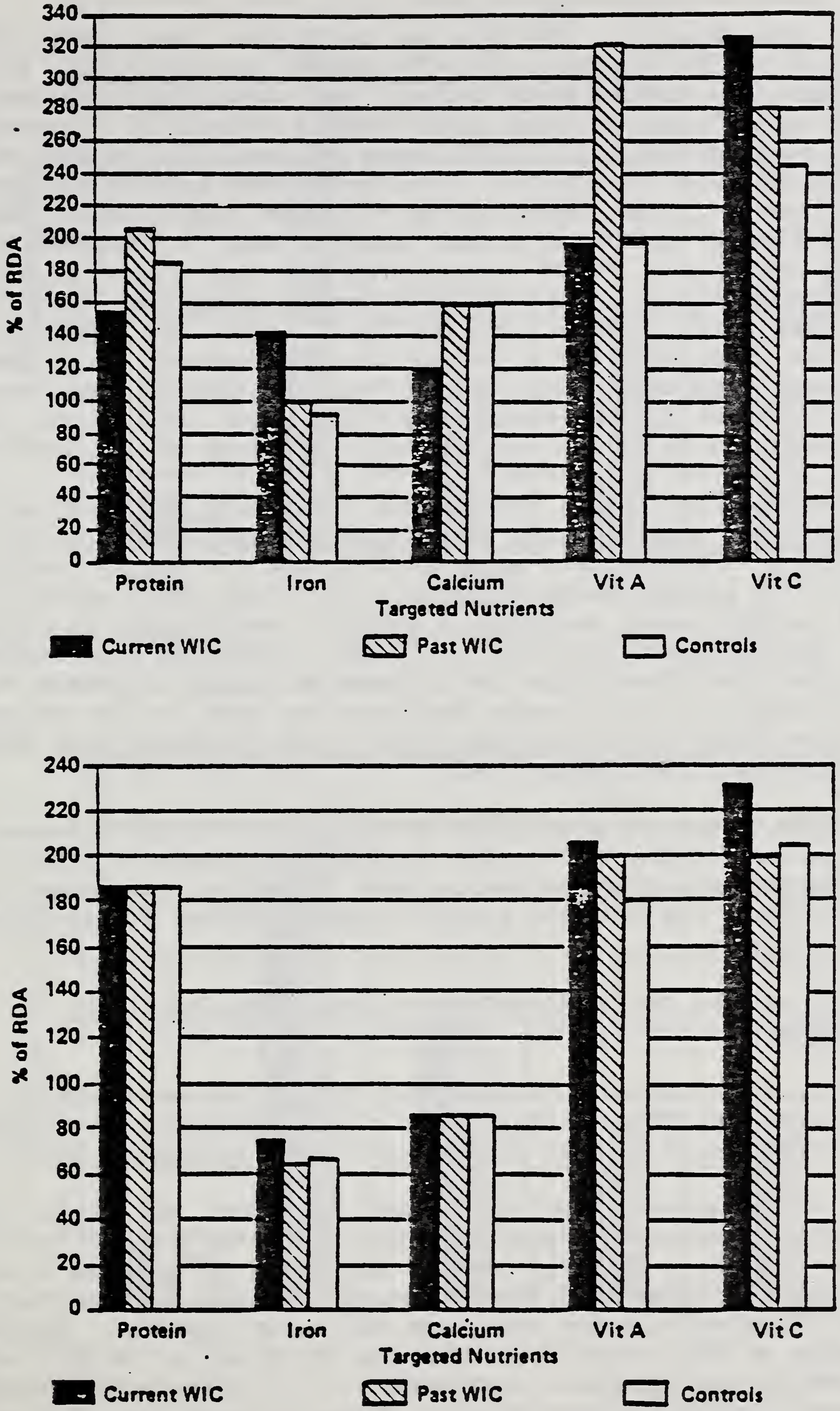


Figure VI-2. Mean nutrient intake for infants and children.

children had low iron intakes. The rate was 14 percent lower among WIC recipients ($p < 0.001$). The effect of the WIC program in reducing the frequency of low intake was greater among infants than among older preschool children, but was significant in both groups (among infants 25.7 percent vs. 54.4 percent among controls, $p < 0.01$; among children 62.3 percent vs. 72.6 percent among controls, $p < 0.01$). Even though mean intakes were not significantly different, infants enrolled in WIC were significantly less likely to have low intakes of Vitamin A than controls were (9.8 percent vs. 21.0 percent among controls, $p < 0.05$). They were also less likely to have low intakes of Vitamin C (9.1 percent vs. 19.6 percent among controls, $p < 0.05$). On the other hand, infants enrolled in WIC were more frequently consuming diets low in calcium (20.6 percent vs. 10.3 percent among controls, $p < 0.05$) and Vitamin B_6 (25.0 percent vs. 14.6 percent among controls, $p < 0.05$). There is no evidence that the lower mean intake of protein in WIC infants is reflected by increased frequency of low intake.

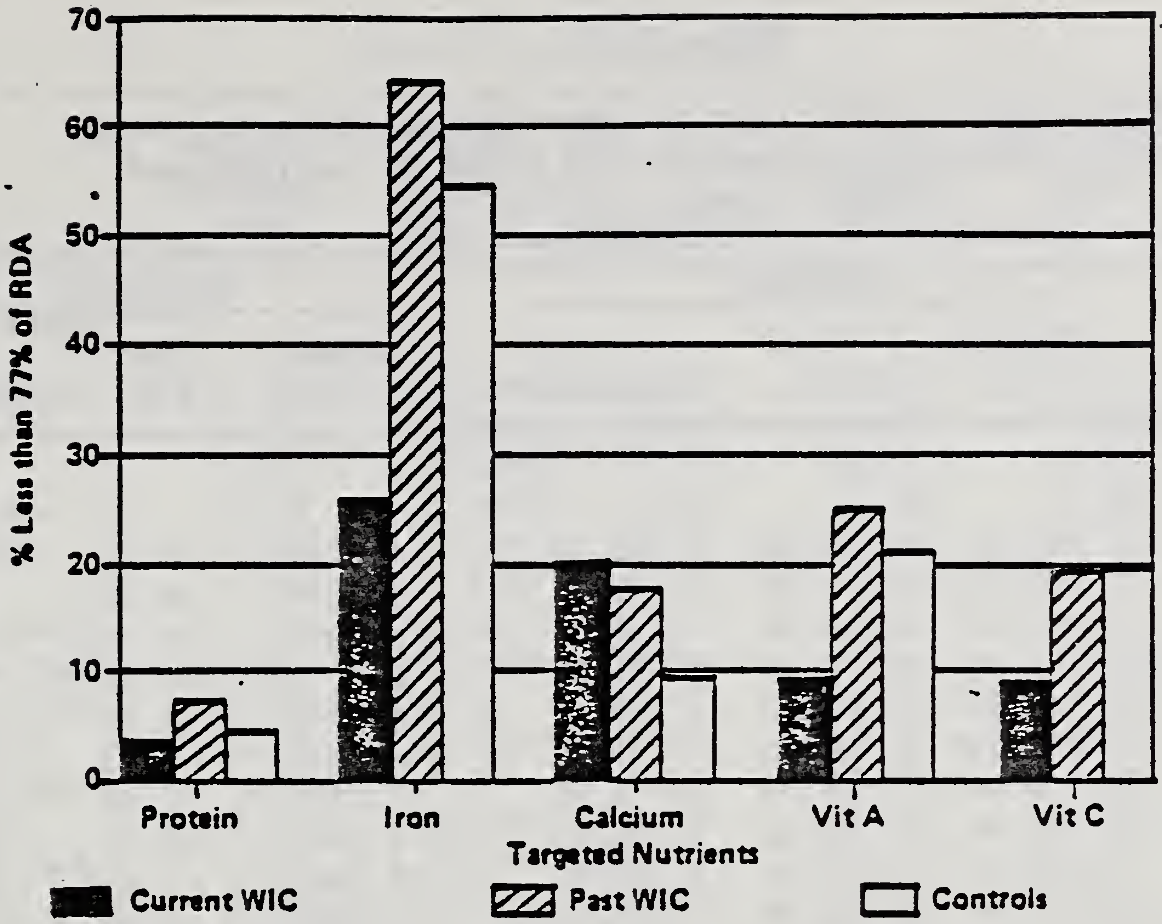
Among children enrolled in the WIC program, there were four nutrients for which low intake was significantly less frequent than among controls: iron (62.3 percent vs. 72.6 percent among controls, $p < 0.01$), Vitamin A (21.3 percent vs. 27.2 percent among controls, $p < 0.05$), riboflavin (7.6 percent vs. 11.5 percent among controls, $p < 0.05$), and Vitamin B_6 (28.5 percent vs. 33.7 percent among controls, $p < 0.05$). Fifty and nine-tenths percent of WIC infants had diets below the recommended energy allowance vs. 57.9 percent of controls (n.s.); among children the rate of low energy intake among WIC participants (63.5 percent) was nearly identical with that of controls (64.5 percent) (see Table VI-4).

Figure VI-3 illustrates the proportion of infants and children consuming less than 77 percent of the RDA for the targeted WIC nutrients, further emphasizing the reduced rate of diets low in iron, Vitamin A, and Vitamin C among current WIC infants and iron and Vitamin A among current WIC children compared to among controls.

Nutrients Derived from the Different Food Groups That Constitute WIC Food Packages

In Table VI-5, the nutrient intake from potential WIC foods is subdivided into that obtained from juices; cereals; dairy products (including formula); and other WIC foods such as eggs, dried beans, and peanut butter.

The sources of incremental nutrient intake by infant and child WIC recipients were very different. Infants enrolled in the WIC program derived only 4 calories a day more from WIC cereals and 10 and 12 calories a day more from WIC juices and "other" WIC foods than controls did, respectively, but they derived 57 calories a day more from WIC dairy products. Except for the contribution of WIC juices to iron intake (0.09 mg, $p < 0.05$), all significant increments in nutrients contributed to the diets of infants from WIC foods were from WIC dairy products. These included iron (7.5 mg, $p < 0.01$), Vitamin A (440 IU, $p < 0.01$), thiamin (0.1 mg, $p < 0.01$), Vitamin B_6 (1.58 mg, $p < 0.01$), and Vitamin C (18.2 mg, $p < 0.01$). The



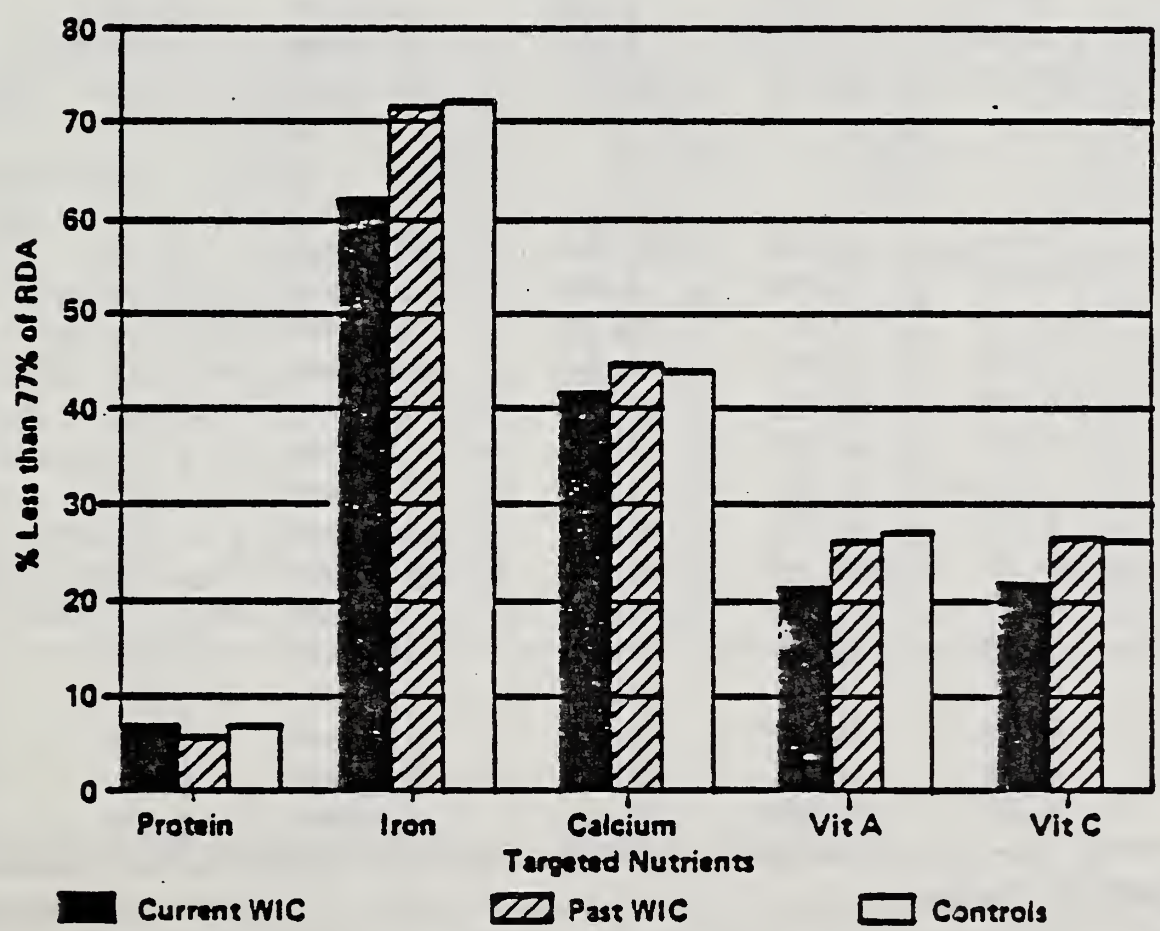


Figure VI-3. Proportion of infants and children <77 percent of RDA.

Table VI-5

Nutrient Intakes for WIC Food Groups--Juices, Cereals, Dairy Products (Including Formulas) and Other by Current and Past Receipt of WIC[a]

Food groups	Infants Current WIC	Infants Past WIC	Infants Controls	Children Current WIC	Children Past WIC	Children Controls
WIC juices						
Calories (kcal)	10.39	1.90	22.38	9.50*	-0.58	31.15
Protein (g)[a]	-0.04	-0.03	0.23	0.13*	-0.00	0.47
Fat (g)[a]	0.02	0.00	0.05	0.02*	-0.00	0.07
Carbohydrates (g)	2.61	0.49	5.40	2.27*	-0.14	7.42
Calcium (mg)	1.60	0.23	4.24	1.87*	-0.10	6.18
Iron (mg)	0.09*	0.02	0.09	0.03*	-0.00	0.08
Magnesium (mg)	0.56	-0.05	3.99	1.95*	-0.09	6.83
Phosphorus (mg)	-0.08	-0.35	5.84	3.05*	-0.11	10.78
Vitamin A (IU)	-8.56	-6.70	69.01	38.26*	-0.81	130.95
Thiamin (mg)[a]	-0.00	-0.00	0.03	0.02*	-0.00	0.06
Riboflavin (mg)[a]	0.00	0.00	0.00	0.00*	-0.00	0.01
Niacin (mg)[a]	0.00	-0.01	0.11	0.06*	-0.00	0.20
Vitamin B_6 (mg)[a]	0.01	0.00	0.02	0.01**	-0.00	0.02
Vitamin B_{12} (mcg)[a]	0.00**	0.00**	0.00	0.00**	0.00**	0.00
Vitamin C (mg)	15.67	3.23	25.45	10.10**	-0.64	31.02
WIC cereals						
Calories (kcal)	3.62	6.86	28.06	21.38**	2.47	14.25
Protein (g)	-0.06	0.06	1.01	0.42**	-0.02	0.42
Fat (g)	-0.01	0.01	0.55	0.14**	0.01	0.11
Carbohydrates (g)	0.95	1.67	4.80	4.70**	0.60	2.96
Calcium (mg)	3.49	5.91	55.32	6.76*	-0.66	7.50
Iron (mg)	0.34	1.29	4.65	2.01**	0.13	1.54
Magnesium (mg)	0.00	3.20	11.08	2.70**	-0.51	2.84
Phosphorus (mg)	0.76	9.91	37.70	10.13**	-1.10	9.11
Vitamin A (IU)	40.06	176.23*	-6.56	429.24**	68.39	181.18
Thiamin (mg)	0.02	0.08	0.18	0.18**	0.02	0.08
Riboflavin (mg)	0.03	0.07	0.17	0.15**	0.02	0.08
Niacin (mg)	0.31	0.99	2.15	1.79**	0.21	1.00
Vitamin B_6 (mg)	0.02	0.07*	0.02	0.18**	0.03	0.08
Vitamin B_{12} (mcg)	0.05	0.20	0.01	0.52**	0.07	0.23
Vitamin C (mg)	0.51	2.07*	0.04	4.97**	0.77	2.01

See footnotes at end of table.

(continued)

Table VI-5 (continued)

Food groups	Infants: Current WIC	Infants: Past WIC	Infants: Controls	Children: Current WIC	Children: Past WIC	Children: Controls
Other WIC foods						
Calories (kcal)	11.52	46.19**	23.25	-7.66	-6.04	81.76
Protein (g)	0.75	2.72**	1.53	-0.47	-0.30	4.95
Fat (g)	0.78	2.29**	1.34	-0.57	-0.35	5.13
Carbohydrates (g)	0.33	3.79**	1.25	-0.15	-0.42	4.06
Calcium (mg)	4.46	16.18**	9.45	-3.09	-2.61	29.93
Iron (mg)	0.13	0.52**	0.30	-0.07	-0.07	0.90
Magnesium (mg)	1.72	13.44**	4.11	-1.22	-1.15	16.53
Phosphorus (mg)	11.91	46.91**	25.40	-7.40	-5.13	81.40
Vitamin A (IU)	27.50	54.04	55.42	-15.45	-5.12	149.75
Thiamin (mg)	0.00	0.03**	0.01	-0.00	-0.00	0.04
Riboflavin (mg)	0.02	0.04*	0.03	-0.01	-0.00	0.09
Niacin (mg)	0.01	0.41**	0.08	-0.04	-0.03	0.54
Vitamin B_6 (mg)	0.01	0.04*	0.02	-0.01	-0.00	0.07
Vitamin B_{12} (mcg)	0.06	0.11	0.13	-0.04	-0.01	0.33
Vitamin C (mg)	0.00**	0.00**	0.00	0.03	0.05	-0.01
WIC dairy						
Calories (kcal)	57.31	-39.40	413.92	13.10	9.33	221.14
Protein (g)	-5.10**	-1.21	19.36	0.19	0.49	12.30
Fat (g)	3.49*	-2.86	21.52	0.84	0.51	11.56
Carbohydrates (g)	3.16	-1.86	32.51	0.83	0.68	17.50
Calcium (mg)	-231.55**	-22.51	685.15	9.46	18.59	442.33
Iron (mg)	7.50**	-0.86	4.15	0.27**	0.01	0.44
Magnesium (mg)	-19.44**	-5.01	76.18	1.15	1.91	48.04
Phosphorus (mg)	-196.57**	-11.80	531.01	7.26	14.99	346.32
Vitamin A (IU)	440.22**	-85.01	1,100.03	18.57	16.05	511.17
Thiamin (mg)	0.10**	-0.03	0.31	0.01	0.01	0.15
Riboflavin (mg)	-0.18**	-0.06	0.98	0.02	0.02	0.59
Niacin (mg)	1.58**	-0.14	1.40	0.08**	0.01	0.39
Vitamin B_6 (mg)	0.01	-0.02	0.28	0.01	0.01	0.15
Vitamin B_{12} (mcg)	-0.59**	-0.08	2.12	0.03	0.06	1.33
Vitamin C (mg)	18.18**	-2.19	14.97	0.74**	0.09	3.92

*$p<0.05$.
**$p<0.01$.
***$p<0.001$.

[a]Juices contain only slight traces of these nutrients.

[b]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

greater milk intake by controls than by WIC recipients was reflected by larger amounts of protein, calcium, magnesium, phosphorus, riboflavin, and Vitamin B_{12} in their diets from dairy products.

Children over 12 months of age enrolled in the WIC program derived about half their incremental caloric intake from WIC cereals (21.4 kcal, $p < 0.01$, vs. controls) and less from WIC dairy foods (13.1 kcal, n.s.) and WIC juices (9.5 kcal, $p < 0.05$).

The greatest contribution to protein and micronutrient intake was from WIC cereals, other than for Vitamin C (primarily from WIC juices) and calcium and phosphorus (primarily from WIC dairy products).

Intake of Formula vs. Whole Milk in Infancy

The separate contributions of formula, of other WIC foods, of milk (which is not included in infant WIC benefits), and of all other foods to the dietary intake of infants under 1 year of age were estimated (see Table VI-6) to understand further the large differences in iron and calcium intake between infants currently participating in WIC and control infants. While no significant difference in total daily energy intake was associated with WIC, current WIC participants, compared to controls, were consuming more calories from formula (263 kcal, $p < 0.001$) and fewer calories from milk (197 kcal, $p < 0.001$). This reflects the WIC package for infants, which provides iron-enriched formula but not milk.

The intake of all other nutrients reflects the greater consumption of formula and lower consumption of milk by WIC recipients. Infants currently enrolled in WIC consumed significantly less calcium than controls did (224 mg, $p < 0.001$). The calcium content of formula varies but is generally lower than that of cow's milk. Thus, the much lower calcium intake from milk by infants enrolled in the WIC program (404 mg, $p < 0.001$) was not fully compensated for by the increased intake from formula (179 mg, $p < 0.001$).

Infants enrolled in WIC consumed 7.9 mg more iron per day than controls ($p < 0.001$). This intake was totally accounted for by greater formula intake (8.0 mg, $p < 0.001$). Milk intake contributed negligible iron to the diet.

Nutrient Intake Stratified by Characteristics of Child and Family

Full specification of all covariates is shown in Table VI-1. Appendix VI-C in Volume IV provides the full results of this analysis for each stratification. In general, there were few consistent interactions among the covariates and WIC enrollment. Table VI-7 provides a summary of statistically significant variables.

Sex of Child. There were no consistent interactions for mean nutrient intake between WIC enrollment and sex of child. Among controls, girls were more likely to have low-nutrient intake than boys, but only the difference

Table VI-6

Nutrient Intake of Infants Under 1 Year of Age from Formula, Other WIC Foods/Milk, and All Other Foods[a]

	Current WIC	Past WIC	Controls
Energy (kcal)			
Formula	262.54***	-31.90	131.24
Other WIC foods	25.54	55.03*	74.01
Milk	-196.63***	-8.79	300.94
Other	-68.29	57.18	389.60
Total	23.16	71.52	895.78
Protein (g)			
Formula	6.29***	-1.14	2.93
Other WIC foods	0.64	2.76**	2.80
Milk	-11.18***	-0.08	16.84
Other	-1.13	2.30	10.56
Total	-5.37*	3.83	33.13
Fat (g)			
Formula	13.98	-1.91	6.88
Other WIC foods	0.79	2.31*	1.96
Milk	-10.04	-1.03	15.56
Other	-2.55	0.72	11.14
Total	2.17	0.09	35.54
Carbohydrate (g)			
Formula	19.70	-1.92	9.67
Other WIC foods	3.89	5.95	11.45
Milk	-15.89	0.16	24.17
Other	-10.65	9.99	64.10
Total	-2.95	14.19	109.40
Calcium (g)			
Formula	178.81***	-19.20	89.54
Other WIC foods	9.56	22.44	69.56
Milk	-404.13***	-3.23	608.20
Other	-8.03	5.01	89.17
Total	-223.78***	5.02	856.47

See footnotes at end of table. (continued)

Table VI-6 (continued)

	Current WIC	Past WIC	Controls
Iron (g)			
Formula	7.97***	-0.90	3.97
Other WIC foods	0.56	1.83	5.04
Milk	-0.32***	-0.04	0.50
Other	-0.35	-0.13	4.01
Total	7.85***	0.77	13.52
Magnesium (mg)			
Formula	25.28***	-3.59	11.47
Other WIC foods	2.28	16.59*	19.20
Milk	-43.89***	-1.32	66.15
Other	-7.02	4.99	49.94
Total	-23.35*	16.68	146.76
Phosphorus (mg)			
Formula	124.37***	-11.57	64.54
Other WIC foods	12.62	56.74*	69.49
Milk	-316.34	0.68	476.05
Other	-17.66	25.46	162.33
Total	-197.02***	71.31	772.41
Vitamin A (IU)			
Formula	941.05***	-122.65	479.41
Other WIC foods	58.99	223.93*	118.84
Milk	-470.68***	41.43	686.11
Other	-548.55	2318.77*	2663.69
Total	-19.20	2461.47*	3948.05
Thiamin (mg)			
Formula	0.24***	-0.03	0.13
Other WIC foods	0.02	0.10	0.21
Milk	-0.14***	0.01	0.20
Other	-0.06	-0.02	0.30
Total	0.06	0.06	0.85
Riboflavin (mg)			
Formula	0.37***	-0.05	0.19
Other WIC foods	0.04	0.12	0.20
Milk	-0.54***	-0.01	0.81
Other	-0.05	0.09	0.35
Total	-0.18	0.15	1.56

See footnotes at end of table.

(continued)

Table VI-6 (continued)

	Current WIC	Past WIC	Controls
Niacin (mg)			
Formula	1.98***	-0.17	1.02
Other WIC foods	0.32	1.40	2.34
Milk	-0.34***	0.00	0.51
Other	-0.93	0.31	4.22
Total	1.03	1.54	8.09
Vitamin B_6 (mg)			
Formula	0.16***	-0.02	0.08
Other WIC foods	0.04	0.11**	0.06
Milk	-0.14***	-0.00	0.21
Other	-0.00	0.13	0.32
Total	0.05	0.22*	0.66
Vitamin B_{12} (μg)			
Formula	0.66***	-0.08	0.32
Other WIC foods	0.12	0.31*	0.14
Milk	-1.23***	-0.00	1.84
Other	0.53	2.70*	0.19
Total	0.08	2.93*	2.48
Vitamin C (mg)			
Formula	22.21***	-2.54	11.39
Other WIC foods	16.18	5.30	25.50
Milk	-3.36***	-0.07	5.07
Other	-7.64	10.16	43.76
Total	27.40*	12.84	85.72
n	178	432	84

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

Table VI-7

Significant Differences in Total Mean Nutrient Intake for Infants and Children by WIC Status and Characteristics of the Infant/Child and Family

	Calories			Protein			Fat		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Sex of child									
Male									
Female									
Age of child									
1-11 months	-8.82	89.69	952.77**	-7.20**	5.43	31.11**	1.80	1.50	36.79
12-23 months	-59.95	6.70	1,116.65	-1.23	1.65	41.85	-1.80	2.43	42.05
24-35 months	74.19	23.99	1,127.25	3.27	1.47	40.20	2.50	0.63	41.55
36-47 months	156.81*	34.88	1,102.43	5.45*	-1.46	41.60	6.77*	-0.56	41.28
48-59 months	-141.17	-93.29	1,399.44***	-8.12*	-2.92	48.56**	-7.79*	-4.06	51.49**
Ethnic group									
White non-Hispanic							0.02	-0.93	44.05
White Hispanic							-1.30	-3.48	43.36
Black							2.14	2.37	38.51**
Other							-5.85	12.73*	39.33
Mother's age									
18-19 years									
20-29 years									
<18 years									
30+ years									
Child Quetelet's index									
<0.135				0.60	4.50	35.29			
0.135-0.175				-0.49	0.03	39.91			
>0.175				-2.61	0.17	44.73**			
Missing				-8.99	-13.37*	52.46*			
Height of child									
0-10 percentile									
11-89 percentile									
90-100 percentile									
AFDC/Food Stamps									
None				-1.10	0.93	40.04			
AFDC only				-11.81*	-6.59	48.58*			
Food Stamps only				-2.51	-0.59	41.30			
AFDC and Food Stamps				0.89	-0.21	43.37			
Mothers education									
<12 years									
12 years									
>12 years									

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Calories			Protein			Fat		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Yearly family income									
$3,000-6,999				-1.53	0.72	40.77			
<$3,000				2.53	1.16	38.31			
$7,000-12,999				-0.80	1.10	41.92			
$13,000+				2.04	-2.06	43.08			
Missing				-6.65*	-5.02	42.89			
Marital status									
Other				0.40	-0.72	41.56			
Married				-2.47*	0.74	41.14			
Presence of father figure									
Absent									
Present									
Size of household									
2				4.57	4.86	36.24			
3				-2.13	-1.12	41.46			
4				-4.32*	-0.60	43.55			
5+				0.71	0.91	41.42			
Presence of father and whether only child									
No/2	99.40*	36.19	1,077.74	3.82*	4.95**	36.55			
No/3+	-46.57	-53.94	1,170.47	-2.19	-1.67	43.07			
Yes/3	42.25	71.28	1,092.07	-0.75	-0.21	40.83			
Yes/4+	-38.98	-36.58	1,162.54	-2.73	0.18	41.07			

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Carbohydrate			Calcium			Iron		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Sex of child									
Male							3.27**	-0.09	10.97
Female							1.84**	0.30	9.91
Age of child									
1-11 months	-8.78	15.69	119.22**	-210.45**	78.78	807.27	8.13**	-0.68	12.68**
12-23 months	-10.58	-5.97	146.46	-26.20	-11.66	786.66	0.48	-1.25	8.97
24-35 months	9.76	3.42	151.84	51.89	40.37	621.42***	2.31*	0.17	9.51
36-47 months	19.05*	15.02*	144.12	107.88*	1.48	592.22***	1.93	0.85	9.86
48-59	-7.57	-10.17	189.13***	-33.94	18.04	709.75	-1.47	0.33	13.70***
Ethnic group									
White Non-Hispanic				-75.91**	-0.24	752.84	2.80**	-0.38	10.83
White Hispanic				-31.84	9.78	735.27	2.05	-0.45	9.61
Black				92.64*	65.17	550.39**	2.39*	0.81	10.24
Other				-210.13	-48.23	788.33	0.85	2.50	9.59
Mother's age									
<18 years				56.37	42.49	686.45	4.14	-0.82	9.86
18-19 years				-123.38*	-53.41	751.22	2.60	1.05	10.16
20-29 years				-28.86	14.75	695.46	2.48**	-0.02	10.47
30+ years				38.05	-4.11	714.50	2.12	0.24	10.59
Child Quetelet's index									
<0.135				63.54	37.39	641.75	2.04	0.55	9.31
0.135-.175				-5.68	11.57	671.94	1.99**	0.18	10.84
>0.175				-68.74	20.68	758.44**	3.50**	-0.47	10.01
Missing				-296.26*	-230.07*	923.17	3.08	1.93	9.20
Height of child									
11-89 percentile				-50.13*	-0.25	700.84	2.20**	0.22	10.32
0-10 percentile				55.43	71.21	694.94	4.26**	-0.41	10.80
90-100 percentile				-16.21	-15.44	718.23	2.55	0.02	10.70
AFDC/Food Stamps									
None	-0.70	10.38*	141.28	-62.00*	33.98	683.72	2.93**	0.63	9.39
AFDC only	7.87	3.13	135.58	-38.22	115.36	692.01	0.88	-1.24	12.53
Food Stamps only	-3.67	-9.20	153.91*	-57.79	-35.84	722.12	2.65**	-1.05	11.08
AFDC and Food Stamps	-5.86	-10.94	167.10***	49.00	-4.90	715.67	1.37	0.12	12.06*
Mothers's education									
<12 years				0.42	16.76	693.19	2.96**	0.44	10.03
12 years				-75.03*	25.96	723.65	1.86*	-0.20	10.68
>12 years				-52.73	79.45	678.18	4.03**	-0.22	11.20

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Carbohydrate			Calcium			Iron		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Yearly family income									
< $3,000							2.26	-0.19	10.32
$3,000-6,999							1.59	0.35	10.57
$7,000-12,999							3.84**	0.56	10.13
$13,000+							1.33	-1.28	10.56
Missing							3.28*	-0.92	11.24
Marital status									
Other				43.73	8.50	701.33	1.44	-0.01	10.94
Married				-74.59**	19.58	696.85	3.24**	0.01	10.21
Presence of father figure									
Absent				51.72	55.19	689.34	0.93	0.03	11.08
Present				66.96**	-6.22	700.03	3.38**	-0.05	10.22
Size of household									
2				97.29	171.05*	598.49	3.67*	0.36	9.89
3				-67.75*	-12.79	720.87	2.19**	0.69	10.24
4				-111.84**	15.86	732.42	2.18*	-1.14	11.63
5+				57.76	3.38	665.46	3.07**	0.35	9.89
Presence of father and whether only child									
No/2	18.13**	2.65	138.35	84.76*	179.54**	607.07	3.48**	0.08	9.90
Yes/3	3.96	17.12*	142.31*	-71.61	9.95	705.51	3.41**	1.08	9.89
No/3+	-9.69	-7.56	153.67	33.16	12.34	712.21	-0.01	-0.07	11.32
Yes/4+	-5.26	-8.07	155.89	-61.52	-18.98	699.49	3.35**	-0.99	10.71

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Magnesium			Phosphorus			Vitamin A		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Sex of child									
Male									
Female									
Age of child									
1-11 months	-28.40**	23.45	148.90	-205.75**	133.10	768.00	-470.80	2,390.96*	4,372.93
12-23 months	-6.46	-3.37	167.86	-41.61	0.95	860.05	437.31	-315.15	3,624.79
24-35 months	6.34	4.05	159.99	52.70	28.96	763.51**	901.27	736.46	3,253.00
36-47 months	19.36	-0.38	153.84	105.02*	-8.80	742.74**	882.67	1,161.15*	2,850.50
48-59 months	-5.36	-4.84	192.43*	-71.62	-10.79	894.10	-932.13	100.41	4,989.79*
Ethnic group									
White Non-Hispanic	-10.78	-1.01	169.41	-75.24**	-6.51	846.59			
White Hispanic	-2.71	-7.43	166.32	-51.56	-33.73	859.97			
Black	8.44	4.48	149.70*	65.70	64.53	671.16***			
Other	-1.99	19.20	160.41	-138.13	63.94	807.39			
Mother's age									
<18 years							1,002.36	1,535.19	3,021.37
18-19 years							772.70	560.95	3,291.86
20-29 years							220.54	277.86	3,734.91
30+ years							336.31	1,736.87*	3,789.75
Child Quetelet's index									
<0.135				-29.93	35.66	749.24	932.89	4,298.69**	3,000.07
0.135-.175				-11.92	8.24	771.94	496.36	528.67	3,558.91
>0.175				-79.61*	9.73	871.61**	-88.88	-262.70	3,885.40
Missing				-165.88	-226.47*	993.15	-709.90	-3,675.90*	5,764.66
Height of child									
0-10 percentile				11.27	37.31	792.91	856.67	766.45	3,511.82
11-89 percentile				-49.45*	0.29	805.44	374.03	607.28*	3,576.59
90-100 percentile				-44.06	-25.23	827.16	-719.14	-676.73	4,519.00
AFDC/Food Stamps									
None									
AFDC only									
Food Stamps only									
AFDC and Food Stamps									
Mother's education									
<12 years				-21.90	-0.60	812.53	830.72	889.08*	3,280.12
12 years				-66.75*	-16.26	809.98	-108.42	-99.34	3,917.62
>12 years				-65.49	75.35	773.84	-276.12	878.61	4,264.40

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Magnesium			Phosphorus			Vitamin A		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Yearly family income									
<$3,000				64.72	59.73	722.76			
$3,000-6,999				-49.58	25.60	799.96			
$7,000-12,999				-40.18	3.59	832.30			
$13,000+				-39.53	-8.82	813.74			
Missing				-120.75*	-130.90*	821.61			
Marital status									
Other	4.53	-3.61	165.53	13.58	-3.33	815.12	199.64	151.31	3,726.43
Married	-10.53*	2.39	162.20	-71.10**	15.67	796.35	387.91	708.46*	3,667.91
Presence of father figure									
Absent				12.73	29.33	800.85			
Present				-62.35**	-3.48	802.91			
Size of household									
2	22.21	16.67	142.45	88.46	152.59	702.38	817.60	937.72	2,567.64
3	-7.70	4.68	162.41	-65.73*	-20.90	816.10	189.63	205.51	3,781.84
4	-21.30*	-4.38	175.40	-118.84**	0.60	844.24	94.07	202.16	3,856.55
5+	4.96	-7.06	160.91	32.39	9.81	775.91	680.79	985.06*	3,592.00
Presence of father and whether only child									
No/2	17.22*	16.32*	143.13+	68.55*	154.42**	709.09			
Yes/3	-3.56	14.58	159.37	-55.91	6.46	803.05			
No/3+	-3.23	-6.62	166.04	-15.60	-15.69	823.78			
Yes/4+	-13.29	-12.32	170.72	-66.31*	-11.83	810.58			

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Thiamin			Riboflavin			Niacin		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Sex of child									
Male	0.09*	0.00	1.02				1.24*	-0.20	11.31
Female	0.06	0.02	0.96				0.63	0.24	10.59
Age of child									
1-11 months	0.05	0.04	0.87	-0.17	0.23	1.53	0.71	0.95	8.72
12-23 months	0.01	-0.06	0.91	-0.01	-0.01	1.56	0.54	-0.52	9.46
24-35 months	0.14*	-0.01	1.01	0.23*	0.14	1.41	2.08*	-0.04	11.51**
36-47 months	0.14	0.10	0.99	0.15	0.03	1.41	0.77	0.62	11.75*
48-59 months	0.01	0.03	1.28***	-0.06	0.12	1.70	-1.31	0.17	14.79***
Ethnic group									
White Non-Hispanic				-0.06	-0.01	1.63	0.96	-0.58	11.26
White Hispanic				0.21	0.01	1.49	0.84	-1.37	10.19
Black				0.20*	0.23*	1.26***	1.10	1.14	10.89
Other				-0.29	0.35	1.44	0.57	5.65**	8.93
Mother's age									
<18 years	0.06	0.12	0.95						
18-19 years	0.13	0.10	0.94						
20-29 years	0.07*	-0.00	0.99						
30+ years	0.06	-0.03	1.01						
Child Quetelet's index									
<0.135				0.35	0.30	1.29	3.46*	0.74	8.70
0.135-.175				0.06	0.10	1.48	0.82	0.36	10.99
>0.175				-0.02	-0.03	1.59	0.84	-0.82	11.43
Missing				-0.61*	-0.39	1.83	-1.63	-0.15	10.49
Height of child									
0-10 percentile	0.20*	0.04	0.92						
11-89 percentile	0.06	0.00	1.00						
90-100	0.01	-0.01	1.01						
AFDC/Food Stamps									
None				0.02	0.13	1.41	1.43*	0.39	9.94
AFDC only				-0.64*	-0.43	2.21***	-2.65	-2.71	14.64**
Food Stamps only				-0.03	0.06	1.54	1.06	0.14	11.16
AFDC and Food Stamps				0.20	0.01	1.59	-0.07	-0.96	12.77**
Mother's education									
<12 years	0.09*	0.04	0.98						
12 years	0.08	-0.01	0.98						
>12 years	0.06	-0.06	1.04						

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Thiamin			Riboflavin			Niacin		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Yearly family income									
<$3,000									
$3,000-6,999									
$7,000-12,999									
$13,000+									
Missing									
Marital status									
Other	0.02	0.00	1.04				-0.13	-0.36	11.54
Married	0.11**	0.01	0.96				1.56**	0.17	10.68
Presence of father figure									
Absent	0.03	0.03	1.01				-0.21	0.12	11.11
Present	0.10*	-0.01	0.98				1.54**	-0.15**	10.92
Size of household									
2	0.27*	0.15	0.84	0.47*	0.36	1.25	2.05	0.40	9.70
3	0.03	0.06	0.97	-0.06	0.06	1.53	0.60	0.21	10.81
4	0.01	-0.07	1.09*	-0.08	0.01	1.56	0.49	-1.12	12.04
5+	0.15**	0.00	0.96	0.14	0.06	1.47	1.51*	0.66	10.54
Presence of father and whether only child									
No/2	0.24**	0.14*	0.84	0.43**	0.34**	1.26	1.72*	0.01	9.68
Yes/3	0.09	0.08	0.94	0.03	0.10	1.52	1.39	0.22	10.78
No/3+	-0.05	-0.01	1.05	0.00	0.03	1.53	-0.96	0.08	11.42
Yes/4+	0.11*	-0.08	1.03	0.03	0.00	1.52	1.69*	-0.46	11.23

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Vitamin B_6			Vitamin B_{12}			Vitamin C			Number of subjects		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Sex of child												
Male							8.50	-4.50	97.49	366	310	380
Female							17.42**	-1.28	86.90	345	327	383
Age of child												
1-11 months				-0.32	3.09**	2.88	22.02*	1.33	90.67	178	32	84
12-23 months				0.14	0.07	3.58	8.56	-7.01	81.29	252	167	224
24-35 months				1.09	0.46	2.96	15.76	-13.02	95.47	162	174	192
36-47 months				0.66	0.62	2.69	2.56	11.90	89.17	71	158	143
48-59				-0.67	0.83	4.05	8.75	-2.73	119.31***	48	106	119
Ethnic group												
White Non-Hispanic	0.06	-0.03	1.03				8.49	-1.71	84.46	402	266	422
White Hispanic	0.14	-0.06	1.07				22.59*	2.79	92.79	78	116	170
Black	0.08	0.10	1.02				10.63	-12.19	108.52**	223	233	137
Other	0.19	0.55**	0.91				82.21*	21.23	96.43	8	22	34
Mother's age												
<18 years				-0.18	-0.13	3.42	25.15	-9.94	74.06	51	21	18
18-19 years				0.29	-0.18	3.53	22.39	15.32	90.00	121	92	63
20-29 years				0.19	0.40	3.30	10.62*	-4.89	92.62	475	465	580
30+ years				0.21	2.68**	2.71	16.69	-8.22	95.58	64	59	102
Child Quetelet's index												
<0.135	0.33*	-0.12	0.86	2.00	6.40**	1.89	-0.64	1.46	83.59	37	58	52
0.135-.175	0.05	0.06	1.03	0.27	0.28	3.15	13.70*	0.53	92.44	415	388	468
>0.175	0.10	0.00	1.07	0.02	0.08	3.43	12.70	-16.13	95.64	239	163	224
Missing	-0.20	0.01	1.13	-2.47	-5.27**	6.72	28.24	34.41	67.41	20	28	19
Height of child												
0-10 percentile				0.28	0.30	3.24	23.31	-13.77	93.26	94	117	91
11-89 percentile				0.42	0.89**	3.06	13.23*	-1.38	91.31	471	522	590
90-100 percentile				-1.04	-1.34	4.50*	-4.86	0.95	97.12	72	72	82
AFDC/Food Stamps												
None							15.41*	3.69	88.70	241	279	471
AFDC only							30.18	23.95	78.33	32	34	23
Food Stamps only							14.45	-11.40	95.07	246	173	161
AFDC and Food Stamps							-1.99	-14.81	103.86	192	151	108
Mother's education												
<12 years				0.72	1.10**	2.96	18.53**	2.28	87.58	403	343	348
12 years				-0.31	-0.47	3.58	12.03	-5.87	71.89	264	225	275
>12 years				-0.18	1.49	3.25	-3.31	-10.33	106.00	44	69	139

See footnotes at end of table.

(continued)

Table VI-7 (continued)

	Vitamin B_6			Vitamin B_{12}			Vitamin C			Number of subjects		
	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls	Current WIC	Past WIC	Controls
Yearly family income												
<$3,000										105	94	71
$3,000-6,999										267	237	216
$7,000-12,999										210	187	270
$13,000+										55	61	132
Missing										74	58	74
Marital status												
Other	0.02	0.03	1.05	0.47	0.35	3.25	0.57	-4.89	96.63	299	296	222
Married	0.11*	0.02	1.03	0.09	0.75*	3.23	20.56**	-3.37	90.47	412	341	541
Presence of father figure												
Absent	0.03	0.08	0.99				3.05	-3.96	91.81	271	252	186
Present	0.11*	-0.01	1.05				18.12**	-3.28	93.03	440	385	577
Size of household												
2	0.27	0.16	0.81*	0.52	1.14	2.58	25.40	3.12	86.82	61	65	44
3	0.03	0.02	1.05	-0.09	0.02	3.57	9.50	4.63	90.77	284	223	333
4	0.00	-0.06	1.14	0.00	0.13	3.23	9.42	-14.05	100.43	142	147	178
5+	0.16*	0.09	0.97	0.98	1.50**	2.82	16.90*	-4.35	89.11	224	202	208
Presence of father and whether only child												
No/2	0.23**	0.13	0.80	0.42	1.09*	2.59	21.59**	2.48	83.38	217	172	281
Yes/3	0.10	0.04	1.04	-0.15	0.12	3.59	18.80*	9.20	86.78	212	189	142
No/3+	-0.05	0.06	1.04	0.20	0.37	3.35	-3.09	-6.28	93.68	59	63	44
Yes/4+	0.12	-0.04	1.08	0.63	1.17*	2.96	16.82*	-14.11	99.56	223	213	296

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Mean for reference group (controls) in far right columns; all other values are differences from reference group for that row.

for protein was significant (8.3 percent of girls vs. 4.7 percent of boys, $p < 0.05$). For all nutrients, the proportion of girls with low intake was lower among current WIC recipients than among controls; the reductions were significant for iron, Vitamin A, riboflavin, and Vitamin C. WIC benefits were significantly associated with reduction of low intake among boys only for iron.

Current Age of Child. There were small numbers of children in various subgroups: only 71 current WIC recipients 36 to 47 months of age, and 48 current WIC recipients 48 to 59 months of age. Reasonable numbers of controls were in all five age groups (the fewest was 84 under 1 year of age), but there were very few past WIC recipients under 1 year of age ($n = 32$). There was little obvious interaction between the age of the child and WIC enrollment on the intake of macronutrients. Although children 36 to 47 months of age currently participating in WIC were consuming 157 calories more than controls ($p < 0.05$), this was probably a chance finding. However, there was strong interaction of WIC enrollment and age on mean intake for several micronutrients. Infant WIC recipients had a higher intake of iron than controls or than infants who had been in the WIC program in the past. The major advantages in thiamin, niacin, and Vitamin B_6 among current WIC recipients were among children from 1 to 3 years of age; after the fourth birthday, WIC was not associated with better diet than that of controls, probably because 4-year-old controls were eating very nutritious diets. The advantage of WIC recipients in Vitamin C intake was greatest among infants, but older children in the program also consumed more Vitamin C than did controls.

Fifty-four percent of control infants were consuming less than 77 percent of the RDA for iron; rates were much higher for children 1 to 3 years of age (71 percent to 81 percent). The effect of WIC enrollment on the frequency of low iron intake was greatest among infants (30 percent decrease, $p < 0.01$). The effect of WIC in reducing the proportion of children with low Vitamin C intake was much greater among infants than among children over 1 year of age. WIC benefits for Vitamin B_{12} were greatest in 3-year-olds; for riboflavin, they were greatest in 4-year-olds. These latter two differences appear to be chance variations, rather than a coherent pattern of differential effects with age.

Ethnic Group. Control blacks reported eating 88 fewer calories than control whites ($p < 0.05$), but the intake for Hispanics was only 19 calories fewer than for whites (n.s.). Among WIC recipients, whites consumed 1,147 kcal, 15 calories fewer than controls, and blacks consumed 1,108 kcal, 34 calories more than black controls. Thus, among WIC recipients, the black-white difference was narrowed to 39 calories (n.s.).

In each of the three major ethnic groups, large and equivalent increases in iron intake were associated with WIC. Among controls, blacks consumed much less calcium than others (202 mg less than white non-Hispanics, $p < 0.01$). This discrepancy was halved by WIC benefits. Although among controls blacks consumed more Vitamin C than any other

ethnic group, blacks also reported significantly less nutritious diets otherwise than whites, probably because of lower milk intake. While these differences were attenuated after control for caloric intake, they were by no means eliminated.

Among control children, blacks had the highest proportion of diets low in energy, protein, calcium, Vitamin A, riboflavin, and Vitamin B_{12}. WIC participation reduced the proportion of black children with diets low in all of these nutrients and significantly so for calcium, riboflavin, and Vitamin B_{12}. The highest percentage of control children with low Vitamin C intake was among whites (30.5 percent). Among white WIC participants, the proportion was significantly lower (21.5 percent, $p < 0.01$).

<u>Age of Mother</u>. Little regular difference in the intake of controls was associated with maternal age, nor was there any obvious pattern of greater or lesser effects of WIC benefits depending on the mother's age.

<u>Child Quetelet's Index</u>.* While relatively few very thin children were in the sample (37 current WIC, 58 past WIC, and 52 control children), they were more prevalent among past than among current WIC recipients (9.1 percent vs. 5.2 percent).

Among controls, the caloric intake of thin children was lowest and the caloric intake of fat children was greatest. Although this is logical, it differs from past consumption surveys, where the most obese generally are reported to eat the least.

The WIC program appears not to be raising the mean caloric intake of the thinnest children: they are reported to be eating 90 calories a day less than thin controls, but this difference was not statistically significant. This caloric difference is reflected in the intake of the macronutrients; but, relative to thin controls, thin WIC recipients were eating more iron, calcium, Vitamin A, thiamin, riboflavin, niacin, Vitamin B_{12}, and Vitamin B_6.

<u>Child's Height</u>. All children were characterized by whether they were below the 11th or above the 89th percentile for height based on sex- and age-specific standards.

The dietary needs of children of short stature who are enrolled in the program appear to be reasonably well met. A deficit of 64 calories among controls of short stature compared to controls of average height was fully compensated for by the WIC program. The shortest children also had greatest increments from the program, compared to comparable controls, for calcium, iron, Vitamin A, thiamin, riboflavin, niacin, Vitamin B_6, and Vitamin C.

<u>Receipt of Food Stamps and Welfare Benefits (AFDC) by the Family</u>. Only 89 children in the survey were in families receiving AFDC and not Food Stamps, and it is difficult to draw any conclusions about their diets.

---

*An index of body mass is defined as [(weight (kg)) × 100]/[length/height (cm^2)].

Control children in families receiving both AFDC and Food Stamps consumed 164 kcal ($p < 0.01$) more, and control children in families receiving Food Stamps only consumed 75 kcal (n.s.) more than control children receiving neither Food Stamps nor welfare benefits. The pattern for other nutrients reflected these caloric differences: controls without these other social benefits had generally lower nutrient intakes.

Among control children, no consistent pattern of frequency of low nutrient intake was associated with Food Stamp or AFDC receipt. WIC participation significantly reduced the proportion of children with low intake of iron, Vitamin A, and Vitamin C among those receiving neither AFDC nor Food Stamps; low intake of calcium among children in households receiving both AFDC and Food Stamps; and low intake of iron and Vitamin A among children in households receiving only Food Stamps.

Maternal Education. Control children of women with more than 12 years of education consumed more iron, Vitamin A, thiamin, niacin, Vitamin B_6, and Vitamin C than children of less educated women. While WIC's effect on iron intake is greatest for children with more educated mothers, incremental intake of other nutrients from WIC was greater for children of women with under 12 years of education (Vitamin A, thiamin, riboflavin, Vitamin B_{12}, and Vitamin C). Thus, with WIC benefits, the gradients of intake in these nutrients with maternal education are considerably lessened or eliminated.

Total Household Income. (The covariates in the fully adjusted analyses include family size; therefore, the reported differences are equivalent to those for per capita income.) Among controls, there was a mild gradient of total caloric intake with income, but not a steep one. Children in families with annual incomes under $3,000 were eating about 40 calories a day fewer than those in families with incomes between $3,000 and $7,000 who in turn were eating 53 calories a day less than those with incomes over $7,000. There was no difference between children in the two higher income categories ($7,000 to $13,000 and over $13,000).

These differences were smaller among current WIC recipients. The increment in calories from WIC was greatest among children in poorest families (59 calories more than children in poor families not receiving WIC); this was a function only of current benefits, since poor children who were no longer in the WIC program had the lowest energy intake of any children in the study.

Beside caloric intake, poorer children were reported to be eating less calcium, magnesium, phosphorus, Vitamin B_6, and Vitamin B_{12} (no differences were significant, however). In each instance, poorest children receiving WIC benefits had higher intakes than poor controls. For the nutrients that were significantly associated with WIC, increments in thiamin, riboflavin, and Vitamin B_6 were greatest for children in poorest families.

Marital Status of the Mother and Presence of the Father in the Household. (Receipt of AFDC, marital status, and presence of father were omitted as covariates in the full regression models in these analyses.) WIC recipient children compared to control children in single-parent families had increased intake of calcium, phosphorus, magnesium, and riboflavin, while other WIC recipient children had lower intakes of these nutrients compared to control children. Conversely, WIC was associated with greater increments in iron, Vitamin A, thiamin, niacin, Vitamin B_6, and Vitamin C among children in intact families, obviously from other than dairy foods.

Size of Household. This analysis addressed whether the diets of children in two-person households (i.e., pregnant woman alone with the index child) or in very large households were worse than in others and whether WIC addressed the special needs of these groups. The highly colinear variables--AFDC, marital status, and father in household--were omitted from the fully adjusted regression analyses.

Iron intake of control children was lowest in households with two or five or more persons, and the increment of iron contributed by WIC to children in such families was 3.0 to 3.5 mg, compared to about 2.0 mg among others. The same pattern of greatest benefits for those presumably at greatest need was also true for Vitamin A, thiamin, riboflavin, niacin, Vitamin B_6, Vitamin B_{12}, Vitamin C, and calcium.

Presence of Father and Household Size Studied Jointly. Given the somewhat contradictory results of outcome stratified by marital status and by family size, the factors were considered simultaneously. The study sample was stratified into four groups: families with the father present and one child or with more than one child (the reference group), and families without the father present and one child or with more than one child.

Sixty-three, or 9.9 percent, of past WIC recipients were in households with more than 1 child and no father, compared to 59, or 8.3 percent, of current WIC recipients. Among controls, children in single-child households were consuming 70 to 90 fewer calories, independent of a father's presence. WIC benefits were associated with increased caloric intake in single-child households (99 kcal without father present, $p < 0.05$; 42 kcals if father present, n.s.), but with an approximate 40-calorie decreased intake in families with more than one child (n.s.).

4. Conclusions

The results appear to be consistent and suggest important dietary benefits from current WIC enrollment. The observed benefits, especially after infancy, were clearly not associated with simple dependence on more dairy foods in the child's diet. Rather, benefits after infancy depended on an increase in the range of WIC foods to result in what appears to be a more healthful diet for these children than for controls or past WIC recipients. (About half of the WIC benefit past infancy was contributed by cereals, with major contributions by dairy foods and juices.)

By far the strongest effect of current WIC benefits is on iron intake, especially in infancy. This seems logical in view of the content of the WIC food packages, which contain iron-fortified formula and cereals. While iron benefits were greater in infancy, older children enrolled in the program also consumed significantly more iron than control children did. WIC participation also significantly decreased the proportion of children whose diets were low in iron.

While mean intakes of calcium, phosphorus, magnesium, and protein were lower among WIC infant recipients than among controls, only the rate of low calcium intake was significantly lower in WIC infant recipients. Lower mean intakes were thus only minimally reflected by greater likelihood of low intake. Because calcium deficiency is not usually considered a problem among infants in the United States, these differences probably do not imply diets deficient in calcium, but these results must be given further attention.

The RDAs bear little relationship to observed intakes both in this survey and in past empirical research. Two questions arise: Do the observations of this study lose credibility because they are only minimally related to the RDAs, and what is the utility of supplementing children who already have adequate diets by the criteria of the RDAs? Results of this study are very much like those of past surveys, which is probably reasonable evidence of credibility. On the other hand, the utility of supplementing nutrients eaten on average in quantities much higher than that of the RDA is a serious concern. However, on a given day, large numbers of children still consume less than 77 percent of the RDA for many nutrients (the level considered adequate for long-term intake for half of the population, see Table VI-4). This justifies supplementing large groups of children to bring the minority up to standard. Also, the RDA is, at best, an informed guess of optimal intakes: by the criterion of what people <u>do</u> eat rather than what they <u>should</u> eat, the greater intake may be more appropriate. This question is well outside the scope of this investigation, however. Finally, some nutrients may be present in the diet in larger than necessary amounts in the process of foods being supplied that contain nutrients only available in marginal amounts.

All statistically significant relationships past infancy of increased nutrient intake with WIC are limited to those currently enrolled in WIC. Past receipt of WIC benefits appears to have only slight, if any, residual relationship with current dietary intake. Thus, any possible residual effects of past nutrition education on long-term child feeding practices are limited to some infants and subgroups of children and are not reflected in total study population. For iron, a key WIC nutrient, differences in intake among past WIC beneficiaries compared to those of the control group were only about 0.1 to 0.3 mg (n.s.), while differences among those receiving current WIC benefits compared to controls were 10 times as great and highly significant.

While no differences were significant, past WIC recipient children were reported to consume more micronutrients and to have more nutrient-dense diets than controls.

Not surprisingly, current WIC recipients were consuming significantly more calories from WIC foods than controls were. However, the total caloric intake of the three study groups was essentially identical and unaffected by WIC enrollment. Thus, almost all differences associated with WIC benefits are in quality of diet, or nutrient density, rather than increased total food intake.

Results suggest that dietary intake was improved by current enrollment in the WIC program, with only minimal if any impact of beneficial residual effects of past WIC participation. While almost all differences were in increased nutrient intake among children who had been enrolled in the WIC program in the past, compared to controls, the differences were of small magnitude and none were statistically significant other than a few in infancy. The control group was more socially privileged than were past WIC recipients, but adjustments for social differences had only trivial impact on estimated program effects, suggesting that better statistical adjustment would not materially affect these estimates. It is doubtful that real residual benefits would have been obscured by these social disparities.

The evidence is strong that the WIC program is having its greatest impact on those presumed to be at greatest need: children who were poor, short in stature, black, in isolated families consisting of only the pregnant mother and preschool child, and in large families (those with five or more members). On the other hand, large numbers of past WIC recipients were in these needy families (65, or 10.2 percent, of past WIC recipient children were in 2-person households, and 202, or 31.7 percent, were in households of 5 or more people). These vulnerable children might well benefit from nutritional support.

On the evidence of this survey, the WIC program should be alerted to the needs of thin children and to the intake of heavy children. WIC was not associated with increased caloric intake by thin children, but the sample size of thin children was relatively small. It is reassuring that the energy intake of heavier children was also not increased by WIC food supplements. Heavy WIC children were not consuming more calories than heavy controls, possibly reflecting effective nutrition education.

WIC benefits were generally comparable in raising the mean level of nutrient intake, independent of welfare or Food Stamps. Thus, the program does not appear to be redundant for those with other benefits; rather, it appears to have additive and complementary effects. On the other hand, the likelihood of low intake was decreased by WIC participation most among children receiving neither AFDC nor Food Stamps.

Children enrolled in the WIC program from single parent but multiple-child families, presumably those at great need, seem to benefit least from the WIC program. For instance, they did not have increased iron intake compared to comparable controls. Single children living alone with their mothers benefit from WIC enrollment, but children in larger single-parent households have no such demonstrable improvement.

Characteristics of Children No Longer Enrolled in the WIC Program

It became obvious as this analysis proceeded that children who were no longer enrolled in the WIC program had characteristics that suggested that, as a group, they were probably as vulnerable to nutritional risk as were current WIC recipient children. For instance, while relatively few very thin children were in the sample (37 current WIC, 58 past WIC, and 52 control children), more were among past than among current WIC recipients (9.1 percent vs. 5.2 percent).

A higher proportion of past WIC recipients (117, or 16.4 percent) were at or under the 10th percentile for height, compared to 94, or 14.8 percent, of current WIC recipients. Seventy, or 11.3 percent, of current WIC recipients and 72, or 10.1 percent, of past WIC recipients were at the 90th or greater percentile for height. There appear to be as many children in greatest need of WIC benefits among those who are no longer enrolled in the program as there are among those who are currently enrolled. Of past WIC recipient children, 65, or 10.2 percent, were in 2-person households, and 202, or 31.7 percent, were in households of 5 or more people, compared to 8.6 percent and 31.5 percent, respectively, among current recipients. (Children in these single-parent and large households appeared to need dietary supplementation most.) The 14.8 percent of past WIC recipient children, the same rate as among those currently enrolled, lived in households with incomes under $3,000 a year. Many children who were past WIC recipients and who would appear to need program benefits were either lost to the program or were not recertified (one cannot distinguish between these two possibilities from available data). These include short and thin children, poor children, and children in large single-parent families. The frequency of these characteristics was as high or higher among those no longer in the program than among those currently enrolled.

Children who appear to need WIC services are either leaving the program still thin or short or are losing gains after discharge from the program. These results suggest strongly that after children leave the program they should be reassessed periodically throughout the preschool years.

Effect of Potential Bias on Conclusions

Reported dietary intakes of children in this study support the conclusion that the WIC program has been successful in supplementing the diets of current WIC recipients. The pattern where improved nutrient intake was associated predominantly with current rather than past WIC participation minimizes the possibility of observed effects arising because interviewers were not blind to study status (observer bias). Those who performed the recalls could not know that analysis would be relative to whether benefits were current, and specification of the child's WIC benefits was required in the mother's questionnaire. This segment of the questionnaire was remote in time from the child's dietary recall and preceded the child's history, which was the other source of information on the child's participation in WIC. More than half of the control children and the vast majority of those who were past WIC recipients were children of women in the WIC clinic sample. Thus, had interviewer bias functioned in favor of the WIC program,

the expected bias would be toward greater intake by children of WIC women, including most past childhood WIC recipients and over half of the controls. That specification of the WIC variable for children was therefore independent of the mother's study status would further minimize observer bias in generating results favoring current WIC recipients. These results appear unlikely to have been the result of systemic observer bias in study design in favor of current WIC program recipients.

C. ANTHROPOMETRY

1. Introduction

Eligibility criteria for participation by infants and children in the WIC program include inadequate growth patterns, such as low weight or low weight for height, obesity, or growth retardation. The following anthropometric indices were measured on children in the study sample to determine the extent to which differences or improvements in these patterns are associated with WIC participation: weight, stature, head circumference, arm circumference, and skinfold thickness. The rationale for these measurements, including evidence for response to dietary supplementation, is described in the paragraphs that follow.

Weight

Weight reflects current and past caloric intake, as well as other factors such as illness, activity, and individual metabolism. Although a child's weight increases most rapidly in the first 18 months of life, there is less response in weight to dietary supplementation during this period than subsequently, at least in Western populations (Edozien et al., 1976a, b, 1979; Roche and Himes, 1980; Stebbins, 1981). Among non-Western children, supplemental feeding programs appear to affect growth less than might be expected, except among the most severely deprived children (Martorell et al., 1980; Beaton and Ghassemi, 1982).

Various studies have reported increases of 0.06 to 1.00 kg in the mean weight of Western preschool children following long-term food supplementation. For example, in a randomized controlled trial of dietary supplementation in New York City among poor black pregnant women at high risk of low-birthweight delivery, Rush et al. (1980a, b), studied the effects of prenatal supplementation with high-protein, high-calorie Supplement and balanced protein and calorie Complement. At 1 year of age, infants whose mothers received Supplement and Complement during pregnancy weighed 0.13 and 0.07 kg more than controls, respectively. At three Massachusetts WIC sites Heimendinger (1981) found that combined pre- and postnatal nutritional supplementation was associated with about 0.12 kg greater weight and that postnatal supplementation alone was associated with differences of about 0.5 kg for children 18 months of age compared to the weight of children from local health clinics. In the first large-scale evaluation of the WIC program, Edozien et al. (1976a,b, 1979) reported effects of 6 months of WIC participation on 1-, 2-, and 3-year-old children's weights to be 0.17, 0.26, and 0.39 kg, and the effects of 11 months of WIC participation to be 0.15, 0.13, and 0.18 kg. Comparisons were with children of the same age

who were new WIC recruits. In a cross-sectional study at four Head Start sites in 1980, Abt Associates (Stebbins, 1981) found that WIC benefits accompanying Food Stamps, compared to Food Stamps alone, were associated with 0.29, 0.33, and 0.31 kg heavier weights in 3-, 4- and 5-year-old children. Three-year-old Guatemalan children who lived in villages supplied with high-protein Supplement from which they derived, on average, 153 calories and 10.8 g protein daily from at least 15 months of age weighed 1.0 kg more than children who lived in villages supplied low-calorie, protein-free supplementation from which they derived, on average, an additional 25 calories each day (Martorell et al., 1980).

Stature

Linear growth reflects the adequacy of long-term protein and calorie nutrition, as well as nonnutritional factors. Length and height are highly correlated with parental stature, particularly after 2 years of age (Himes et al., 1981).

Rush et al. (1980a, b) found no effect of prenatal Complement on length at 1 year; children who received prenatal Supplement were 0.20 cm longer than controls. Reported effects of food supplementation on the length or height of preschool children have ranged from 0.25 to 1.28 cm. Edozien et al. (1976a, b, 1979) estimated effects of 6 and 11 months of WIC participation on length/height to be 0.35, 0.52, and 0.90 cm and 0.45, 0.65, and 0.95 cm, respectively, for 2-, 3-, and 4-year-old children. Abt Associates (Stebbins, 1981) found that 3-, 4-, and 5-year-old children who received WIC and Food Stamps were 1.00, 1.17, and 1.28 cm taller, respectively, than those who received Food Stamps only. Three-year-old Guatemalan village children who received high-protein and high-calorie supplementation were 2.5 cm taller than children receiving low-calorie, protein-free supplementation (Martorell et al., 1980).

Head Circumference

The additional Supplement and Complement during pregnancy was associated with differences of 0.05 and -0.06 cm in head circumference of infants at 1 year of age (Rush et al., 1980a, b). Short-term nutritional supplementation in childhood appears to be only weakly related to changes in head circumference. Six months of WIC participation (Edozien et al., 1976a, b, 1979) was associated with 0.12, 0.11, and 0.00 cm larger head circumference, in 1-, 2-, and 3-year-old children, respectively, and 11-month WIC participation with 0.06, 0.02, and 0.03 cm larger head circumference at the same ages. However, Martorell et al. (1980) reported that supplementation among 3-year-olds who had received high-protein and high-calorie supplementation from at least 15 months of age (many had lifelong supplementation) had head circumferences 1.05 cm greater than children with low-calorie, protein-free supplementation, a large difference.

Head circumference is greater among children of higher socioeconomic status. Between 1968 and 1972 the Ten State Nutritional Survey (U.S. DHEW, 1972) studied a large number of children, most of whom were poor. Differences in mean head circumference between high- and low-income-ratio States

were 0.78, 0.57, 0.32, 0.60, and 1.1 cm for 1-, 2-, 3-, 4-, and 5-year-old children, controlled for sex and race. The Collaborative Perinatal Survey of NINCDS (Niswander and Gordon, 1972) studied approximately 35,000 children from their mother's pregnancy through early childhood and found that mean head circumferences of high SES children were greater than those of low SES children by 0.46, 0.55, and 0.61 cm at 1, 3, and 4 years of age, controlled for sex and race. Cook et al. (1976) observed that boys in private nursery school had head circumferences 1.10 cm larger than boys enrolled in Head Start. Rush et al. (1982) in the Child Health and Education Study, a longitudinal study of all children born in England, Scotland, and Wales in the week of April 5 to 11, 1970, found that an increase of one standard deviation in a comprehensive index of social status in 5-year-olds was associated with a larger head circumference of 0.21 cm, controlled for sex, maternal height, and family size.

Skinfold Thickness and Arm Circumference

The proportion of fat in the body can be estimated from skinfold thickness (Cronk and Roche, 1982). The triceps skinfold is the most common measurement site. The subscapular skinfold is the second most common measurement site and is more closely related to total body fat than are peripheral skinfolds (USDHHS, 1981).

Rush et al. (1980a, b) found that 1-year-olds who received prenatal Supplement had 0.11 cm greater arm circumference than controls, but that those who received prenatal Complement had no difference in arm circumference than controls. One-year-old infants in the Supplement group had differences in triceps and subscapular skinfold thickness of 0.20 mm and -0.08 mm, and those in the Complement group of -0.70 mm and -0.17 mm, compared to controls (Rush et al., 1980a, b). Martorell et al. (1980) found no difference in subscapular skinfold, but found a difference of 1.5 mm in triceps skinfold among 3-year-olds associated with high calorie and protein supplementation from at least 15 months of age.

2. Analytic Methods

Seven anthropometric indices of children's nutritional status are presented: weight, height or length, head circumference, arm circumference, triceps and subscapular skinfold thickness, and Quetelet's index. Quetelet's index is defined as $[(\text{weight(kg)}) \times 100]/[\text{length/height (cm)}^2]$ and is an index of body mass. Values of ≤ 0.132, 0.133 to 0.178, and ≥ 0.179 classify children as thin, normal, and fat (derived from WHO, 1983). While this index increases somewhat in the first year of life and then decreases to 6 years of age, it depends less on age and height than on the ratio of weight to length.

Specification of WIC

For this analysis, the sample was stratified by the age at which the child was first enrolled in the WIC program. Nearly 70 percent of the study children began WIC benefits in utero and only about 7 percent at 12 months of age or older. Thus, 993 were children of mothers who received

prenatal WIC benefits, 225 were recruited into the WIC program during the first 3 months of life, 88 were recruited during the rest of the first year, and 105 were recruited after the first birthday. The age of recruitment was unknown for 48 children, and 683 children had never been enrolled in WIC.

The effects of WIC benefits on children's growth may be associated with duration of benefits or with greater responsiveness among younger children; therefore, the effect of duration of WIC benefits was studied, controlling for age at WIC enrollment. The rationale for classifying WIC participation by age of first benefits is that children recruited at different ages probably had different characteristics and were subject to different recruitment priorities. For example, the birthweights of prenatal recruits were significantly higher than those of control children (58 g, $p < 0.05$). While the birthweights of children recruited in early infancy were considerably lower than those of controls (127 g, $p < 0.01$) in the age- and sex-adjusted analysis, birthweights were only 57 g (n.s.) lower in the fully adjusted analysis. Clearly, postnatal recruits were being recruited in part because of low birthweight. Considering the growth of children by age at recruitment helps disentangle the effects of the WIC program on growth from selection bias and distinguish differential effects dependent on stage of development at onset of benefits. Furthermore, the program probably should be judged by the current growth and development of all children who were recruited rather than of only those who have remained in the program. Highly selective factors are involved in remaining in or leaving the program that are likely to bias assessment of program effects on growth. For instance, the less cooperative and noncompliant children may leave the program and are likely to be worse off than those who cooperated with program requirements, independent of any effect of nutrition. On the other hand, given any scarcity in the program's availability, children judged to have met program goals may have been selectively not recertified for WIC benefits, leaving a balance of less successful and less grown children. In this cross-sectional study, it therefore seemed wisest to judge the program by the current size of the child dependent on the age of first recruitment into the program. The quality of program management affects followup efficiency, and the decision of whether or not to recertify the child for WIC benefits reflects the program's priorities and capacity. Both elements of program activity are under legitimate scrutiny in this evaluation.

WIC participation could have been specified in other ways. Classification by whether children were current or past recipients was not logical because, unlike dietary differences, growth is not a function of current benefits but a cumulative effect of benefits over time. It was similarly illogical to compare children of the same current age without taking into account the age of first benefits.

Review of Outlying Values, Corrections, and Exclusions

All measurements for each child were reviewed for coherence and likelihood of error if the child's weight was below 6.5 or above 65 lb, length below 50 or above 100 cm, height below 50 or above 120 cm, head circum-

ference below 30 or above 60 cm, arm circumference below 6 or above 25 cm, triceps skinfold below 3.5 or above 17 mm, subscapular skinfold below 1.5 or above 12 mm, and Quetelet's index below 0.085 or above 0.225. Original data forms were reviewed when measurements were biologically implausible; these were excluded from analyses when they could not be corrected based on the review. These included weight above 75 lb (n = 2), length/height above 140 cm (n = 15), head circumference below 25 or above 70 cm (n = 18), arm circumference below 3 or above 50 cm (n = 2), and Quetelet's indices below 0.05 or above 0.40 (n = 19).

Analytic Strategy

Regression analyses on anthropometric indices were performed for two separate subpopulations of children. The first set of analyses was on weight, height, head circumference, and Quetelet's index and the second on arm circumference and triceps and subscapular skinfold thicknesses. Only children with complete data for each index in the subset of outcomes were included in the respective analyses (n = 683 in the studies of height, weight, Quetelet's index, and head circumference and n = 670 in analyses of arm circumference and triceps and subscapular skinfold thicknesses).

Results are presented as mean values, adjusted by linear multiple regression analysis. The proportions of the very short or tall and very thin or very fat were also used as dependent variables. Results presented are adjusted for age, sex, and an extensive array of social and demographic characteristics of the mother and family (listed in Table VI-1 in the previous section). These covariates are identical to the set used in the dietary analyses with the addition of the mother's and father's statures and a variable to account for whether the height of the father was known but excluding the child's length/height. The fully adjusted regression equation for height is presented in Volume IV, Appendix VI-C, as an example of the analytic approach, as is the model adjusted only for age and sex. Appendix VI-C also provides results for both the age- and sex-adjusted and fully adjusted analyses.

The individual coefficients in the full regression equation must be interpreted cautiously because many of the variables in the equation are highly intercorrelated. For instance, the coefficient for age, with the second-order term for age included in the equation, is the relationship with age holding constant the second-order relationship. This is almost impossible to interpret. Also, because the presence of a father in the household is highly correlated with whether the mother is married (r = 0.81), these coefficients are difficult to interpret. This colinearity in no way interferes, however, with the primary purpose of including these covariates in the analysis, which is to adjust outcomes for any differences in distribution of these characteristics across study groups.

Outcome Stratified by Various Nutritional Risk Factors

The relationship of WIC program enrollment to growth was explored within various subgroups of children among whom the program might be more or less effective in promoting optimal growth. Stratification variables

included sex, age, birthweight, and ethnic group of the child; height, age, and years of education of the mother; whether the family is receiving Food Stamps or welfare (AFDC); family income; and whether the mother is married and the father of the unborn child is living in the household. The proportion of children at the extremes of growth was stratified by sex, age, ethnicity, and whether the family is receiving Food Stamps or welfare (AFDC). The goal was to judge whether the benefits of the WIC program are greater given membership in groups presumably at higher nutritional or social risk. These stratified analyses are not linearized estimates of outcome; rather, each cell is independently adjusted for all covariates in the regression equation (Cohen and Cohen, 1983).

3. Results

The results are presented in the remainder of this chapter. The mean for the reference group, all children who have never received WIC benefits (controls), is presented in the far right column.* All other values in the row are increments from the reference group mean. Statistical significance is noted for differences between control and WIC group means and, in the analyses in which the study population is stratified by prior risk characteristics, for differences within the control group.

Relative Growth of the Study Population

Mean anthropometric measurements for study children stratified by age at first WIC benefits are presented in Table VI-8. Growth indices were related to reference values, particularly the WHO-recommended NCHS/Fels growth tables (reference tables are included in Volume IV, Appendix VI-C), to compare the growth of the children in this study with that of other children.

The mean length of study children measured recumbent was 77.5 cm, in the 54th percentile for their mean age (15.4 mo). Children measured standing had a mean stature of 92.1 cm, in the 37th percentile for their mean age (34.5 mo).† For either infants or children, the mean weights of the study population are very close to these reference standards, as is mean length. Mean height, however, is low. The mean weight and length or height of study children were compared to national reference standards by

---

*The contrast group in the tables of mean values is not always the first group in logical sequence. The contrast group is large to facilitate significance testing.

†A caveat is that at the mean age of this study population (28.4 mo) Recumbent length is reported to be 1.5 to 2.0 cm greater at 28 months than stature (WHO, 1983). Because some of the children in this study will have been measured recumbent with others measured standing, the length and height of study children have been compared to the appropriate reference standards separately. Comparisons of these means to median reference standards are probably justified because differences between mean and median measurements are minimal. (Median values are generally used to evaluate anthropometric data since the distribution of growth measurements in human populations deviates somewhat from normality.)

Table VI-8

Anthropometric Measures: Mean by Age at WIC Inception[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Weight (kg)	-0.0837	-0.1212	-0.3165	-0.0089	-0.1004	12.9597
Height/length (cm)	-0.8633**	-1.1194**	-0.8752	-0.8052	-0.6212	88.1738
Quetelet's index (kg*100/cm^2)	0.0025*	0.0040*	-0.007	0.0021	0.0001	0.1661
Head circumference (cm)	0.0440	-0.1054	0.0619	-0.2726	-0.2080	47.9941
n	993	225	88	105	48	683
Arm circumference (cm)	-0.1168	-0.1455	0.0133	-0.0581	-0.6332**	15.9998
Mean triceps skinfold (mm)	-0.1489	-0.0885	-0.2881	0.0074	-0.0076	6.4722
Mean subscapular skinfold (mm)	-0.1302	0.1397	-0.1295	0.1895	-0.0421	4.4717
n	982	225	87	99	46	670

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

current age and age at first WIC benefits (see Table VI-9). While relatively few study children were recruited into WIC after 3 months of age, their weight and length were close to the referent median, while height fell slightly below national standards. Figure VI-4 illustrates the percentiles for height/length by age at inception into WIC.

The combined N-HANES I and II Survey standards were used for arm circumference and triceps and subscapular skinfolds (USDHHS, 1981). (However, while these standards are for wide age ranges of infants and children, the numbers of preschool children on which they were based were small.)

Table VI-9

Percentiles for Mean Weight, Length, and Height by Current Age and at WIC Inception Compared to WHO Standards (1983)[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Current age (mo)						
Weight (percentile)						
0-11	58.0	76.5	59.4	-	64.4	62.8
12-23	54.5	50.4	43.9	59.8	85.3*	59.7
24-35	50.3	55.7	50.5	47.9	72.0	45.6
36-47	50.5	32.0*	45.3	41.0	42.4	47.6
48-59	41.5*	49.0	19.7*	57.7	51.7	49.1
Length (percentile)						
0-11	51.5	59.0	62.8	-	78.5	66.2
12-23	41.1	45.5	43.6	47.8	27.2	44.5
Height (percentile)						
24-35	39.2*	36.0	35.8	46.5	68.7	53.5
36-47	43.2	23.8**	34.0	25.3*	54.9	48.0
48-59	33.0*	45.3	30.6	41.4	23.9*	42.2

	Age at WIC inception (mo)						
Age of child (mo)	Prenatal	0-3	4-11	12+	Unknown	Controls	Total
0-11	151	34	19	0	5	76	285
12-23	330	57	33	22	14	197	653
24-35	258	59	16	22	9	162	526
36-47	146	51	12	32	8	128	377
48-59	108	24	8	29	12	120	301
Total	993	225	88	105	48	683	2,142

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Percentile for reference group (controls) is in far right column; all other values are compared to reference group for that row.

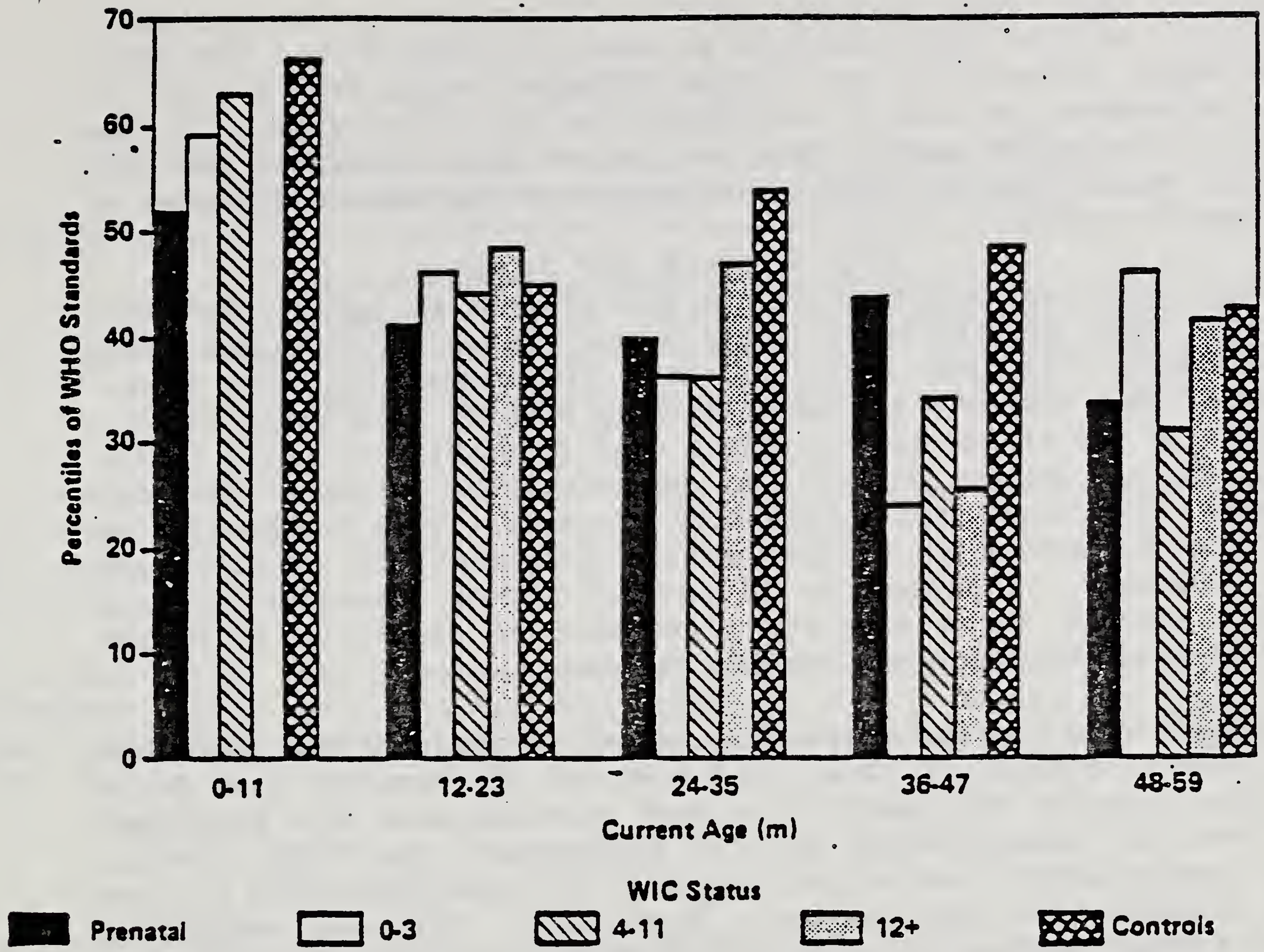


Figure VI-4. Percentiles for mean length/height by age at WIC inception.

The mean arm circumference of controls in this study of 16 cm is close to the 50th percentile of the standard population between 2 and 3 years of age. However, N-HANES reports a mean triceps skinfold thickness of about 10.0 mm, while the mean in this study is 6.5 mm, close to their 8th percentile. They also report a mean subscapular skinfold thickness of about 5.5 to 6.0 mm, while the mean in the current study is about 4.5 mm, around the 20th percentile. While skinfold measurements are difficult to standardize, and the training and monitoring procedures of this study could have been more extensive given the relative inexperience of the data gatherers, the study children still appear to have lower fat stores than would be expected from the available reference standards.

In summary, the population studied did not appear to be particularly aberrant for mean weight, length, or arm circumference but had somewhat shorter standing height and smaller head circumference than expected. Triceps and subscapular skinfolds were much thinner than those reported by N-HANES I and II.

Differences in Growth Associated with WIC Program Participation

Children who have been involved in the WIC program are consistently and substantially shorter than controls as shown in Table VI-8. The deficits in mean height between WIC and control children ranged from 0.8 to 1.2 cm and were independent of age at enrollment in the WIC program. For the two study groups for which sample sizes are large--those recruited into WIC in the prenatal period and from birth to 3 months of age--these differences are highly significant ($p < 0.01$).

Those who were first enrolled in the WIC program in infancy had substantially (but not statistically significant) lower birthweights than controls did, while children recruited into WIC prenatally were significantly heavier than controls by almost 58 g ($p < 0.05$) (see Table VI-10). Low birthweight is one of the risk criteria used to certify children in the WIC program, and the height deficits of postnatal WIC recruits probably reflect program recruitment and eligibility criteria. When birthweight is controlled, the difference in height between postnatal WIC recruits and controls is reduced by 15 percent to 26 percent. Thus, these differences in birthweight account for a moderate proportion of disparity in height between postnatal WIC recruits and control children.

WIC recipient children had relatively better circumferential head than linear body growth, especially those with prenatal WIC benefits (see Table VI-8). Analyses relating WIC benefits to head circumference were performed controlling both for length/height and for birthweight (see Table VI-11). With current length/height controlled, prenatal WIC recipients had 0.13 cm larger head circumference than controls ($p = 0.20$). This was reduced to 0.09 cm after further controlling for birthweight, suggesting that about 40 percent of the difference was mediated by accelerated birthweight.

The significant differences in arm circumference are difficult to interpret. The significantly thinner arms of the 46 children whose mothers did not know when their children were recruited into WIC, compared to controls, is of uncertain meaning. This is a small group, and the mother's inability to recall this information may be an index of low awareness. The mean arm circumference of infants whose mothers began receiving WIC benefits during pregnancy was significantly smaller than that of controls. The meaning of this difference is uncertain.

The mean subscapular skinfold thickness of children recruited into the WIC program after their first birthday was substantially, if not significantly, greater than that of controls (the number of subjects was small). These older recruits also had somewhat greater mean Quetelet's indices and slightly thicker triceps skinfolds than controls. It is likely that some of them enrolled in the program because they were overweight, given that obesity is a recruitment criterion for postnatal recruits.

Outcome Among Infants and Children Separately

These analyses (see Table VI-12) are presented not only because of the administrative distinction between infants and children by the WIC program,

Table VI-10

Mean Birthweight (g) by Age at WIC Inception Adjusted for Sociodemographic Differences, Age, and Sex[a]

Age at WIC inception (mo)					
Prenatal	0-3	4-11	12+	Unknown	Controls
57.95*	-57.47	-20.55	25.95	-46.90	3,217.59

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

Table VI-11

Mean Head Circumference (cm) Controlled for Birthweight and Stature and for Age, Sex, and Sociodemographic Characteristics of Family[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Not controlled for stature	0.04	-0.11	0.06	-0.27	-0.21	47.99
Controlled for birthweight	0.00	-0.01	0.13	-0.22	-0.19	48.00
Controlled for stature	0.13	0.01	0.15	-0.19	-0.14	47.93
Controlled for birthweight and stature	0.09	0.09	0.15	-0.16	-0.14	47.95

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

Table VI-12

Anthropometric Measures by Age at WIC Inception, Separately for Infants and Children[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Infants						
Weight (kg)	-0.182	0.4100	0.027	-	-0.830	9.050
Height/length (cm)	-1.201	-0.0030	0.364	-	-2.956	71.944
Quetelet's index ($kg*100/cm^2$)	0.0038	0.0088	-0.0002	-	-0.0002	0.1738
Head circumference (cm)	0.098	-0.007	0.491	-	-1.304	44.636
n	154	34	19	0	5	69
Arm circumference (cm)	-0.603*	0.314	0.722	-	-1.039	15.346
Mean triceps skinfold (mm)	-0.064	0.237	1.211	-	0.483	6.224
Mean subscapular skinfold (mm)	0.155	0.753*	1.180*	-	0.210	4.437
n	154	35	20	0	5	63
Children						
Weight (kg)	-0.038	-0.198	-0.314	-0.026	-0.069	13.585
Height/length (cm)	-0.733**	-1.102**	-0.771	-0.853	-0.606	90.720
Quetelet's index ($kg*100/cm^2$)	0.0024	0.0023	-0.0010	0.0019	0.0002	0.1650
Head circumference (cm)	0.086	-0.012	0.039	-0.265	-0.114	48.469
n	857	191	71	105	43	612
Arm circumference (cm)	-0.035	-0.256	-0.104	-0.051	-0.633*	16.104
Mean triceps skinfold (mm)	-0.165	-0.205	-0.448	-0.047	-0.042	6.503
Mean subscapular skinfold (mm)	-0.163	0.003	-0.294	0.140	-0.073	4.460
n	828	190	67	99	41	597

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

including different priorities for certification and different food packages, but also for possible insight into differential response to benefits given age at recruitment. (See Appendix VI-C in Volume IV for differences further stratified by single years of age.)

The pattern of the relationship of WIC benefits to current anthropometric status is slightly different for infants than for children, although not statistically significant. Among those who first received WIC benefits in utero, the deficit in weight and length is greater among infant WIC beneficiaries than among preschoolers. Infants who began WIC benefits in utero are 1.2 cm shorter and 182 g lighter and had arm circumferences 0.60 cm ($p < 0.05$) smaller than controls; among older children recruited in utero, the deficit is 0.7 cm in length ($p < 0.01$), only 38 g in weight, and 0.04 cm in arm circumference. This pattern is consistent with the narrowing of an initial WIC control disparity as the child grows older, with differences between successive cohorts of children enrolled into the program that existed prior to, or over and above, program enrollment, or with chance variation.

<u>Duration of WIC Benefits and Child Growth</u>

Duration of benefits is strongly correlated with the child's age and cannot be studied without controlling for age. Furthermore, children recruited into the WIC program before birth had very different characteristics than those recruited later (e.g., recruits in the first 3 months of life had lower birthweights than controls; prenatal recruits had significantly higher birthweights, see Table VI-10). The relationship of duration of WIC benefits to growth was studied within strata of children defined by age at first WIC benefits, with linear multiple regression analyses that included not only age at initial recruitment into the program but also separate interaction terms between duration of benefits and age at onset of benefits for each subgroup of children in the analysis. The coefficients for the group differences based on age at onset of benefits are not presented; none were significant, and they are not meaningful since they are the estimated intercept values at zero duration of benefits. The coefficients of the interaction between duration and age at inception presented in Table VI-13 are, however, directly interpretable. They are the estimated difference between control children and children in the subgroup of WIC recipients defined by age at onset of benefits for each additional month of WIC benefits.

All but a few relationships of growth with duration of WIC benefits are negative, including the one significant relationship (smaller arm circumference with longer benefits among those recruited from birth through the third month of age).

These results are consistent with an interpretation that duration of WIC benefits is almost certainly a confounded variable and that if WIC benefits were successful in improving a child's growth, that child was less likely to be recertified in the program. Current participants in the WIC

Table VI-13

Duration of WIC Benefits and Growth, by Age at WIC Inception[a]
(Results Expressed as Change per Additional Month of Benefits)

	Age of WIC inception (mo)			
	Prenatal	0-3	4-11	12+
Weight (kg)	-0.001	-0.016	-0.030	-0.000
Length/height (cm)	-0.023	-0.047	-0.066	-0.084
Quetelet's index ($kg \times 100/cm^2$)	0.00007	-0.00003	-0.00010	0.00019
Head circumference (cm)	-0.008	0.019	-0.018	-0.014
Arm circumference (cm)	-0.000	-0.018*	-0.017	0.022
Triceps skinfold (mm)	-0.012	-0.021	-0.046	0.035
Subscapular skinfold (mm)	0.002	-0.007	-0.028	-0.002

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

program would thus be, on average, less successful and responsive to the program's goals for whatever reasons. They could have been less compliant, had greater initial growth deficits, or had lower growth potential. Withdrawal from the WIC program because of family disinterest, lack of successful program followup, or both were likely to be associated with a bad outcome.

No firm conclusions can thus be drawn by analyzing duration of program participation. A better sense of how duration affects program participation can be inferred from results stratified simultaneously by age at first benefits and age at assessment. Results of this analysis allow more secure inference on the possibility of better gains from longer duration of WIC benefits.

Frequency of Aberrant Growth

Total Study Population. All children were classified as at or below the 10th or at or above the 90th percentile for sex- and age-specific standards for weight, length/height, head circumference, arm circumference, and triceps and subscapular skinfold thicknesses. WHO growth tables were used for weight and height standards through 60 months of age and for length and head circumference through 36 months of age (WHO, 1983). Head circumference standards from 36 through 60 months were derived by Roche and Himes from the Fels Longitudinal Growth Study data (1984). Standards for arm circumference and triceps and subscapular skinfold thicknesses were derived from NCHS combined HANES I and II data (USDHHS, 1981).

As Table VI-14 shows, the only significant relationship between WIC and aberrant growth was an increased likelihood of arm circumference at or below the 10th percentile among prenatal WIC recipients compared to controls (20.2 percent vs. 15.8 percent, $p < 0.05$). This difference was contributed entirely by boys.

Infants and Children Studied Separately. Among infants, differences were significant among controls, those recruited in utero, those recruited in the first 3 months of life, and those with unknown age at recruitment. Significantly more infant prenatal recruits had arm circumferences at or below the 10th percentile (39.8 percent vs. 22.9 percent, $p < 0.05$). Infants who entered the WIC program in the first 3 months of life had significantly increased rates of arm circumference and subscapular skinfold thickness at or greater than the 90th percentile (20.1 percent vs. 7.4 percent, $p < 0.05$, and 11.3 percent vs. 0.6 percent, $p < 0.05$, respectively). (See Table VI-15.)

Among children, the only significant difference was in the analysis controlled only for age and sex: the frequency of head circumference at or over the 90th percentile among prenatal WIC recruits was significantly greater than for controls (11.3 percent vs. 7.4 percent, $p < 0.05$). In the fully adjusted analysis, this difference was no longer significant (10.8 percent vs. 7.9 percent).

Anthropometry, Stratified by Selected Characteristics of the Child, Mother, or Family

Some caution is required in the interpretation of these results because, for those recruited after 3 months of age, the numbers of children in some categories are limited. During stratification, attempts were made to retain adequate numbers for the analyses and continue to use meaningful categories. Each table includes the numbers of subjects in each cell to help the reader interpret results. In general, the numbers of subjects for the contrast between prenatal or early postnatal recruits and controls are large enough so that results are reasonably robust. The tables with detailed results are lengthy and can be found in Volume IV, Appendix VI-D. The following paragraphs summarize the results.

Table VI-14

Frequency of Aberrant Growth (≤10th, ≥90th Percentile), by Age at WIC Inception[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Weight ≤10th percentile	0.0047	0.0131	0.0243	0.0442	-0.0084	0.1290
Weight ≥90th percentile	-0.0298	-0.0259	-0.0512	-0.0071	-0.0562	0.1435
Height/length ≤10th percentile	0.0325	0.0376	0.0682	0.0384	0.0306	0.1199
Height/length ≥90th percentile	-0.0128	-0.0014	-0.0279	-0.0213	0.0176	0.1124
Head circumference ≤10th percentile	-0.0126	0.0167	-0.0193	-0.0071	-0.0093	0.2825
Head circumference ≥90th percentile	0.0183	0.0013	0.0110	-0.0182	0.0046	0.0936
n	1011	225	90	105	48	691
Arm circumference ≤10th percentile	0.0441*	0.0213	-0.0233	-0.0182	0.0903	0.1582
Arm circumference ≥90th percentile	-0.0008	-0.0001	0.0324	-0.0357	-0.0303	0.1033
Mean triceps skinfold ≤10th percentile	0.0363	0.0227	0.0629	0.0479	-0.0134	0.6177
Mean triceps skinfold ≥90th percentile	-0.0000	0.0016	-0.0178	0.0076	0.0031	0.0153
Mean subscapular skinfold ≤10th percentile	0.0287	-0.0368	0.0042	-0.0595	0.0006	0.4645
Mean subscapular skinfold ≥90th percentile	-0.0098	0.0156	-0.0279	0.0107	-0.0220	0.0453
n	982	225	87	99	46	670

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

Table VI-15

Frequency of Aberrant Growth (≤10th, ≥90th Percentile) by Age at WIC Inception[a]

	Infants: age at WIC inception (mo)					
	Prenatal	0-3	0-11	12+	Unknown	Controls
Weight ≤ 10th percentile	-0.0446	-0.0381	-0.0271	-	-0.1490	0.1793
Weight ≥90th percentile	-0.1245	0.0612	-0.1296	-	-0.1855	0.2693
Height/length ≤10th percentile	0.0346	0.0262	0.0007	-	0.0944	0.1340
Height/length ≥90th percentile	-0.0370	-0.0363	0.0350	-	-0.1864	0.1789
Head circumference ≤10th percentile	-0.1112	0.0215	0.0088	-	0.4339	0.2330
Head circumference ≥90th percentile	-0.0439	-0.0379	0.1196	-	-0.1214	0.1870
n	154	34	19	0	5	69
Arm circumference ≤10th percentile	0.1685*	-0.0135	-0.1923	-	0.3542	0.2287
Arm circumference ≥90th percentile	-0.0334	0.1271*	0.1142	-	-0.0534	0.0740
Triceps skinfold ≤10th percentile	0.1085	-0.0359	-0.1433	-	0.0514	0.4746
Triceps skinfold ≥90th percentile	0.0147	-0.0010	0.0143	-	0.0109	0.0014
Subscapular skinfold ≤10th percentile	-0.0154	-0.0090	-0.2139	-	-0.0375	0.4089
Subscapular skinfold ≥90th percentile	0.0234	0.1070*	0.0775	-	0.0043	0.0056
n	154	35	20	0	5	63

See footnotes at end of table.

(continued)

Table VI-15 (continued)

	Infants: age at WIC inception (mo)					
	Prenatal	0-3	0-11	12+	Unknown	Controls
Weight <10th percentile	0.0064	0.0257	0.0227	0.0501	0.0097	0.1236
Weight >90th percentile	-0.0159	-0.0445	-0.0148	-0.0029	-0.0506	0.1254
Height/length ≤10th percentile	0.0290	0.0385	0.0719	0.0409	0.0216	0.1199
Height/length ≥90th percentile	-0.0127	0.0008	-0.0268	-0.0211	0.0272	0.1048
Head circumference ≤10th percentile	0.0002	0.0129	-0.0264	-0.0037	-0.0608	0.2930
Head circumference ≥90th percentile	0.0286	0.0083	-0.0050	-0.0141	0.0126	0.0789
n	857	191	71	105	43	612
Arm circumference ≤10th percentile	0.0255	0.0401	0.0062	-0.0173	0.0791	0.1445
Arm circumference ≥90th percentile	0.0038	-0.0222	0.0253	-0.0353	-0.0301	0.1076
Triceps skinfold ≤10th percentile	0.0312	0.0457	0.0920	0.0430	-0.0303	0.6379
Triceps skinfold ≥90th percentile	-0.0029	0.0007	-0.0195	0.0063	0.0030	0.0175
Subscapular skinfold ≤10th percentile	0.0286	-0.0307	0.0261	-0.0565	0.0001	0.4786
Subscapular skinfold ≥90th percentile	-0.0148	-0.0013	-0.0428	0.0053	-0.0267	0.0505
n	828	190	67	99	41	597

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

Outcome by Sex of Child. Boys with program experience beginning under age 1 were significantly more likely to be under the 10th percentile in height, while there was only a very weak negative relationship among girls. The decrements in mean height among boys associated with WIC program enrollment were greater than those among girls. Conversely, the sparing or acceleration of mean head circumferential growth among children recruited into WIC in early life, compared to controls, was limited to boys (the head circumference of girls recruited before the first birthday was smaller than that of controls and among those recruited in the first 3 months of life, significantly so).

Age at Assessment, Within 1-Year Strata. This analysis addresses both the effect of duration of benefits and of possibly greater responsiveness to nutritional supplementation among younger children. If therapy throughout early childhood is necessary to correct growth deficits, full program effects might be expected only among older children who had been enrolled in the program early in life. In fact, height decrements between prenatal WIC recruits and controls were unrelated to age at assessment and were significant for prenatal recruits under age 1 and at 2 and 4 years of age. The proportions of children at or under the 10th or at or over the 90th percentile for growth indices, simultaneously by age at observation and at first WIC benefit, were examined. Relative to the standards used, the study population was overrepresented at both extremes: for height and weight, more than 10 percent of controls were both under and over standard. Fifteen percent of control infants were at or under the 10th percentile for weight, 27 percent were at or over the 90th percentile, 14 percent were at or under the 10th, and 17 percent were at or over the 90th percentile for length. Given that such a high proportion of infant controls were heavy, it is probably not cause for concern that infant prenatal WIC recruits were significantly less likely to be heavy (16 percent were still at or over the 90th percentile for weight).

Birthweight and WIC Benefits. Growth deficits associated with low birthweight (<2,501 g) might be ameliorated by later participation in the WIC program. The deficits in current height between prenatal WIC recipients and control children were no different among low-birthweight infants than among others. The only significant discrepancy between WIC recipients and control children in length was among children with low birthweight whose WIC benefits began in the first 3 months of life; they were 1.1 cm shorter than controls ($p < 0.05$) but had head circumference 0.2 cm larger (n.s.).

Mother's Height. The rationale for this analysis is that WIC benefits might be more important for children of short women. There was no regular relationship between mother's height and either the deficit in mean height among prenatal WIC recipients or the possible sparing effect of prenatal WIC benefits on child's head circumference, nor was there a regular pattern relating mother's height and WIC benefits with the child's arm circumference or skinfold thicknesses.

Children of short mothers who were recruited in the first year of life ($n = 32$) had deficits in height, weight, and head circumference at the time of the survey. Possibly they were small infants of relatively low birthweight who were thus recruited into the program and who were genetically small. However, the small number of such children precludes firm conclusions.

<u>Ethnicity</u>. The hypothesis leading to this analysis was that Hispanic and black children would profit preferentially from WIC benefits because they were more likely to come from families with low incomes and thus be more vulnerable to nutritional deficit compared to whites. However, all the women recruited into this study were of low income, so ethnic differences in income should have been smaller than for the U.S. population as a whole. While not straightforward, there is some evidence that WIC benefits begun in utero or in infancy were preferentially effective among minority children. There were large differences in children's stature by ethnic group. Among controls, in the age- and sex-adjusted analysis, blacks were nearly 1 cm taller than whites ($p = 0.08$) and Hispanics were 1.4 cm shorter ($p < 0.01$). In the fully adjusted model, the black-white difference fell to 0.18 cm ($p < 0.05$), probably accounted for by control for parental stature.

Among Hispanic children entered into the WIC program when they were in utero, the discrepancy in current height associated with WIC program enrollment was less than half that of any other ethnic group (-0.35 cm vs. -1.02 cm for whites and -1.07 cm for blacks, Hispanics vs. whites and blacks combined, $t = 1.51$, $0.10 < p < 0.15$). Hispanic children who entered the WIC program in the 1st 3 months of life again had smaller discrepancies in height than white or black children, and those who entered between the 4th and 11th months of life were considerably taller than controls (1.2 cm), while white and black children who entered at that age were considerably shorter than controls. None of these relationships were significant alone, but the pattern strongly suggests special benefit among Hispanic children.

There is significant evidence for increased head growth among black children whose mothers began WIC benefits when these children were in utero. The frequency of head size at or over the 90th percentile was 16.8 percent among them vs. 8.6 percent among controls ($p < 0.01$). The general shift was upward in head size: their rate of head circumference at or under the 10th percentile was 20.5 percent vs. 26.6 percent among controls (n.s.), and their mean head circumference was 0.19 cm greater than that of controls (n.s.). Relationships were not that strong among whites or Hispanics.

<u>Maternal Age and Outcome</u>. There was no obvious interaction of maternal age with effects of WIC benefits and no suggestion that children of younger women were better protected from deficits in stature by the program, although few mothers were less than 20 years old.

<u>Receipt of Food Stamps and/or AFDC</u>. The interrelationships among receipt of WIC, AFDC, and Food Stamps with the child's growth were analyzed

to assess whether effects from these various programs were additive and complementary or possibly redundant. Among controls, children who had only AFDC benefits differed from others. They were significantly taller and had larger arm circumferences than those who were never beneficiaries of either program, but there were only 18 such children. There was little in the way of obvious interaction between WIC and the other programs, either on mean growth or on the likelihood of being at the extremes of growth.

Mother's Education. While the intent of the WIC program is to aid those with the most limited resources, in this case least education, it is also plausible that mothers with more education might use benefits more efficiently. Therefore, this analysis was approached without a strong directional hypothesis. In the results controlled only for age and sex, control children whose mothers had more than 12 years of education were 0.5 cm taller than children whose mothers had 12 or fewer years of education. There was no difference, however, after adjustment for all covariates. There was no consistent interaction between mother's education and WIC benefits on the child's stature. Although not significantly different from controls, the strongest association of prenatal WIC benefits with larger head circumference (0.4 cm) of the child was among children of women with more than 12 years of education. WIC enrollment in the prenatal or immediately postnatal periods was associated with smaller mean arm circumference and thinner mean skinfold thickness among children of women with fewer than 12 years of education than among controls, but such control children (of mothers with the least education) had the largest arm circumferences and the thickest skinfolds.

Family Income. Family income was stratified into four levels: under $3,000, $3,000 to $7,000, $7,000 to $13,000, and greater than $13,000. Approximately one-third of subjects were in each of the two middle-income categories and about one-sixth in each of the two extreme categories. Because family size was included in the regression model, the relationships are equivalent to per capita income. There was no coherent pattern suggesting interaction of family income and WIC benefits with outcome.

Marital Status and Father in Household. Because marital status and the presence of a father are very highly correlated ($r = 0.81$, $p < 0.001$), marital status, AFDC, and presence of father were omitted from the regression models. The deficit in mean height among WIC recipients was substantially greater in children whose mothers were married. Mean height of WIC recipient children of married mothers who were enrolled in WIC in utero was significantly less than of controls (1.18 cm, $p < 0.01$) and among those recruited from 0 to 3 months of age (1.34 cm, $p < 0.01$), with a comparable (1.4 cm) but not significant discrepancy among children recruited from 4 to 11 months of age. Thus, the deficit in mean height among WIC recipients was substantially greater in children whose mothers were married. The sparing effect of prenatal WIC benefits on head circumference was also greater among children of unmarried mothers. Differences in height (and weight) were not due to children of married controls being exceptionally tall; they were only 0.2 cm taller than control children of unmarried women. One possible explanation is that intact families requiring assistance may be particularly deprived, given that they are aberrant from the

population from which they are drawn, or that WIC benefits must be shared among more family members and the effects are therefore diffused. Results for presence of the father in the household were parallel to those of marital status.

Presence of Father and Household Size. The relationships of WIC benefits to children's diets stratified separately by marital status and family size were possibly inconsistent. Therefore, child growth was stratified simultaneously by marital status and family size. The reference group consists of children from families with fathers present and at least two children in the household. The other three groups were children from families with fathers but only one child and single-parent families with either one child or more.

There is little evidence from these results of particular risk based on father's presence, whether the child is an only child, or whether the child is one of several.

4. Conclusions

This was a cross-sectional study, and inferring longitudinal program effects is therefore difficult. These results are interpreted as follows:

- From the children's anthropometry, it appears that the WIC program is being targeted towards an appropriate population. While interpretation is clouded by the multiplicity of available reference data, children participating in the WIC program are short relative both to external standards and to control children in the study and are therefore appropriate beneficiaries of nutritional intervention.

- A wide array of economic, social, and demographic variables were employed to control for differences between the WIC group and controls. Intensive efforts were made to gather control children into the study who would be as comparable as possible to WIC recipients. However, the results of this study suggest that, at this time, the controlled study of effects of WIC benefits on children is likely to be somewhat flawed, and this may be inevitable. The WIC program is so widely diffused that finding a representative group of children at comparable social and nutritional risk who are not enrolled in the program may no longer be possible.

- Although WIC participants were consistently and regularly shorter than controls, those recruited into the program early in life had no comparable deficit in head circumference. The analysis of head circumference controlled for child's height showed larger head circumference associated with early WIC benefits, but these differences were not statistically significant. The effects were greatest among black children. While caution is necessary before accelerated head growth is ascribed to WIC benefits in early life, in the Longitudinal Study of Pregnant Women, head circumference in newborns whose mothers received WIC benefits in pregnancy was significantly larger than that of controls (see Chapter V). Program enrollment in early life led to significantly greater infant fat deposition without significant differences in linear growth.

- There was some evidence of beneficial program effects specific to minority children enrolled in the program early in life. Hispanic children who entered the program during the first year of life or who were enrolled in the WIC program in utero had far smaller discrepancies in height, compared to controls, than did white or black children. Black children whose mothers entered the program during pregnancy had significant evidence of greater head growth than black controls: the proportion of children over the 90th percentile in head circumference was significantly greater than among black controls, and, while not significant, mean head size was larger and frequency of head size under the 10th percentile lower than among controls.

- Interpretation of differences in growth between WIC program participants and controls must be approached with caution, given that control group children were more socially privileged. However, because statistical adjustment procedures did not markedly change any of the differences in stature between WIC participants and controls, it is probably not social disparity that led to these differences.

- Evidence exists that the anthropometric status of postnatal WIC recruits is confounded by selection bias. Postnatal recruits had lower birthweight than controls and were likely also to have been recruited into the program because of short stature, thinness, obesity, etc., so that current group differences from controls in part reflect their status on program entry.

Comparisons between prenatal recruits and controls are probably less confounded by this kind of selection bias, and prenatal recruits did have a birthweight advantage over controls. However, these are children of women who were at risk of delivering low-birthweight infants and who were selectively enrolled into the program because of such risk factors, which may have led in turn to later short stature, despite positive effects on birthweight. It is impossible, however, to discount the possibility that the lower intakes of calcium, phosphorus, magnesium, and protein by infants enrolled in the WIC program may have been related to these deficits.

Control children are better grown than WIC recipients, presumably a reflection of selective recruitment into and retention in the program of less well-grown children (and high-risk women during pregnancy). While in a cross-sectional study it is not possible to ascertain growth status before WIC intervention, recruitment of less well-grown children into the program obviously occurred.

- Advantageous effects of prenatal WIC benefits on birthweight, while not reflected by continued advantageous linear growth, were associated with later head growth equivalent to that of controls. Given that in the Longitudinal Study of Pregnant Women, newborns whose mothers received prenatal WIC benefits had significantly better head growth, these two consistent observations imply likely program effects, albeit requiring further confirmation.

- If the relatively better head growth of prenatal WIC recruits were a chance finding, the relationship might be expected to vary among children of different ages. In fact, the mean head circumferences of prenatal WIC recruits and controls are nearly equivalent independent of age. These results are therefore more consistent with a causal than a chance relationship between prenatal WIC benefits and relatively accelerated growth of head circumference.

The results among Hispanic and black children whose WIC benefits began in utero or in infancy suggest positive program effects. It is likely that both Hispanic and black controls and WIC recipients are more comparable than white non-Hispanic WIC recipients and controls (white WIC recipients were probably at higher risk than controls). Selection into the WIC program would be expected to lead to recruitment of higher risk and less well-grown black and Hispanic children. However, Hispanic children recruited under 1 year of age had very little decrement in current mean height, and the head growth of black children who began WIC benefits before birth was significantly greater than of control black children.

D. HEALTH CARE INDICES

1. Introduction

A major goal of the WIC program is to facilitate and coordinate the health care of mothers and children. To this end, the purpose of the WIC program is "to serve as an adjunct to good health care during critical times of personal growth and development, to prevent health problems, and to improve the health of low-income citizens who are eligible to participate" (GAO, 1984). Local WIC programs differ markedly in how they coordinate health care services; they are mandated to provide referral and access and not to actually provide specific health care. Infants and children can be referred to WIC by a private physician or public health representative because of an observed nutritionally related problem. Conversely, an infant or child participating in the WIC program may be referred to as a source of health care for any number of reasons: illness, well child

services such as immunization, or assessment of growth and development. Therefore, the relationship of the WIC program with health care providers is inherently complex, which makes the specification of effects of WIC participation on health care utilization difficult.

The WIC program might influence adequacy of immunization and the decisions both to breastfeed and to support continuation of breastfeeding. WIC program participation might also lead to more complete immunization and therefore to reduced risks of certain infectious diseases. However, increased use of preventive services might also lead to increased likelihood of receipt of WIC benefits. Thus, any conclusion on the WIC program's effect is clouded by the possibility that the direction of effect may be from use of preventive services to greater likelihood of enrollment in the WIC program, rather than vice versa.

This chapter addresses whether infants and children who are current or past participants in the WIC program differ from nonparticipant control children in:

- Health status, as perceived by the mother.
- Prevalence of chronic health conditions.
- Rates and duration of past breastfeeding .
- Utilization of preventive health care services.
- Rates of immunization.

2. Analytic Methods

The child's health status is related to current WIC benefits. Other outcomes, including utilization of health care, breastfeeding practices, and adequacy of immunization, are related to age at first WIC participation consistent with analyses of somatic growth and psychology. Outcomes are adjusted for a large array of social and demographic variables (always including age and sex) specified in Table VI-1. Results stratified by the large array of risk factors used in the analysis of anthropometry and diet are not presented; these analyses added relatively little to understanding the issues under study.

3. Results

Seven questions were asked of the mother or primary caretaker concerning the health and health care of the child. The answers are described in the subsections that follow.

Health Status of Children

The mother was asked:

> "Compared to other children (CHILD'S) age, would you say [his/her] health is excellent, good, fair, or poor?"

Table VI-16

Mother's Rating of Child's Health Status by WIC Status of Child

Child's health status	WIC status of child (%) Current	Past	Never	Total
Excellent	42.60	43.46	48.56	45.08
Good	47.83	48.27	44.83	46.86
Fair	8.16	7.04	5.86	6.95
Poor	0.89	0.86	0.43	0.71
Nonresponse	0.51	0.37	0.32	0.39
	100	100	100	100
n	(784)	(810)	(939)	(2,533)

Ninety-two percent of children were rated as having good or excellent health, 7 percent as having fair health, and less than 1 percent as having poor health. The rating of health status was related to current or past enrollment in the WIC program; 9.1 percent of current WIC recipients, 7.9 percent of past WIC recipients, and 6.3 percent of control children were rated as having fair or poor health (chi square, current vs. past vs. never WIC, n.s.) (see Table VI-16). Thus, WIC benefits are received by children perceived by their mothers or primary caretakers to be somewhat less healthy than nonrecipients.

The mother was also asked:

> "Does (CHILD) have a long-lasting physical condition that limits [his/her] ability to walk, run, or play?"

The reported rate of chronic conditions limiting physical activity was only 3 percent ($n = 79$). Some of the conditions mentioned included asthma, bronchitis, epilepsy, and cerebral palsy. Eighty-one percent of mothers of children with chronic conditions said they had sought help from a doctor, nurse, or other medical person. The frequency of chronic conditions was significantly higher among past WIC recipients (4.6 percent) than among other children (2.4 percent among current WIC recipients and 2.5 percent among control children, chi square, past WIC recipients vs. others = 8.28, $p < 0.01$, see Table VI-17).

History of Breastfeeding

The rate of breastfeeding was high in the study population relative to past surveys of low-income mothers. Thirty-six and four-tenths percent of children had been breastfed. Women whose infants were enrolled in the WIC program either in utero or in the first 3 months of life were significantly

Table VI-17

Presence of Chronic Conditions Limiting
Physical Activity by WIC Status of Child

Presence of chronic conditions	WIC status of child (%)			
	Current	Past	Never	Total
Yes	2.42	4.57*	2.45	3.12
No/don't know/nonresponse	97.58	95.43	97.55	96.88
	100	100	100	100
n	(784)	(810)	(939)	(2,533)

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

less likely to have breastfed their infants than controls (9.7 percent less among prenatal recruits and 11.6 percent among recruits in the first 3 months of life). However, after controlling for the full array of social and demographic variables, there was no decrement among prenatal WIC recruits and a nonsignificant decrement of 5.0 percent among early postnatal recruits. The mean duration of breastfeeding for the 796 infants who had been breastfed was 155 days. Prenatal WIC recruits were breastfed 5.5 days longer than controls, but this difference was not significant.

Regular Source of Medical Care

Mothers were asked:

"Is there a particular clinic, health center, doctor's office, or other place that (CHILD) usually goes to if (CHILD) is sick or you need advice about [his/her] health?"

If the mother or caretaker answered affirmatively, she was asked what kind of place this was: a doctor's office, a hospital outpatient clinic, a health center, a hospital emergency room, or other. If there was no regular source of care or the hospital emergency room was used, it was assumed that the child had no regular source of care. Ninety-one percent of children had a regular source of care. Children recruited into WIC under 1 year of age were significantly more likely to have a regular source of health care than controls (for prenatal recruits 3.5 percent more likely, for those recruited in the first 3 months 7.0 percent more likely, and for those recruited from 3 to 11 months 8.7 percent more likely). The 44 children recruited into the WIC program after the 11th month of life were also 4.4 percent more likely to have a regular source of health care, but this difference was not significant. There is a problem, however, in the direction of the causal relationship for postnatal recruits. A child may

have been enrolled in WIC because he or she was a patient in a clinic rather than the other way around. In this cross-sectional study, the sequence of this relationship could not be specified.

Use of Preventive Health Services

The use of preventive health services (see Table VI-18) was defined as the mother or caretaker having taken the child to a medical provider for a routine checkup, immunization, or examination during the past year when the child was not sick. Unlike availability of a regular source of health care, no relationship existed between enrollment in the WIC program and current use of preventive health care.

Although there was no relationship to WIC, the population used preventive health care moderately frequently. Seventy-two percent of all children fulfilled the criterion of having used preventive health care in the year prior to questioning. Prenatal WIC recruits were estimated to have used preventive health care 4.0 percent more frequently than controls, but this was not significant ($p = 0.11$).

Immunization

Four indices of the child's immunization status were related to WIC program participation. The first was whether the mother had some written record of the child's immunizations; the second, whether the child had received measles vaccination (limited to children who were over 15 months of age); the third, whether the Diphtheria/Pertussis/Tetanus (DPT) immunization of the child was adequate (the criteria were three injections under 18 months of age and four injections over that age); and the fourth, whether the child had received adequate vaccination against polio (the criteria were two doses under 18 months of age and three doses over that age).

Immunization Card. Children who entered the WIC program at 1 year of age or older were significantly more likely to have immunization cards than controls were. Those recruited during the first year of life were more likely to have a card, but differences were not significant, and for prenatal recruits there was no difference. Forty-nine percent of mothers had a written record of their children's immunization status.

Measles Vaccination. Seventy-five percent of all children over 15 months of age were reported to have received measles vaccination. Prenatal WIC recruits were less likely and those recruited after the first birthday were significantly more likely to have received measles vaccination. The difference for prenatal recruits was not significant.

Adequacy of DPT Immunization. Only 48.4 percent of children met the criterion for adequate numbers of DPT immunizations. Those recruited into WIC under 1 year of age were significantly more likely to have received adequate DPT immunization, and those recruited over 1 year were also more likely to be adequately immunized, but not significantly so.

Table VI-18

Child Health Measures by Age of First WIC Benefits[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Proportion breastfed	0.002	-0.051	0.069	0.015	0.050	0.364
n	1,058	237	93	109	51	727
Duration of breastfeeding among breastfed children (days)	5.41	-23.14	-12.83	17.91	-27.20	155.14
n	344	69	43	38	20	291
Proportion with regular source of medical care	0.041**	0.072**	0.076*	0.042	0.050	0.876
n	1,055	237	93	108	50	720
Proportion using preventive health care	0.036	0.015	0.010	0.014	-0.032	0.704
n	1,058	237	93	109	51	727
Proportion with immunization card available	0.029	0.056	0.087	0.112*	0.131	0.456
n	1,058	237	93	109	51	727
Proportion with measles immunization (children over 15 months)	-0.032	0.044	-0.009	0.105*	0.034	0.758
n	765	179	64	102	38	562
Proportion with adequate DPT immunization	0.055*	0.096*	0.158**	0.088	-0.025	0.438
n	970	217	83	98	47	655
Proportion with adequate polio immunization	0.046	0.095*	0.019	0.029	0.042	0.637
n	978	210	85	96	46	666

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

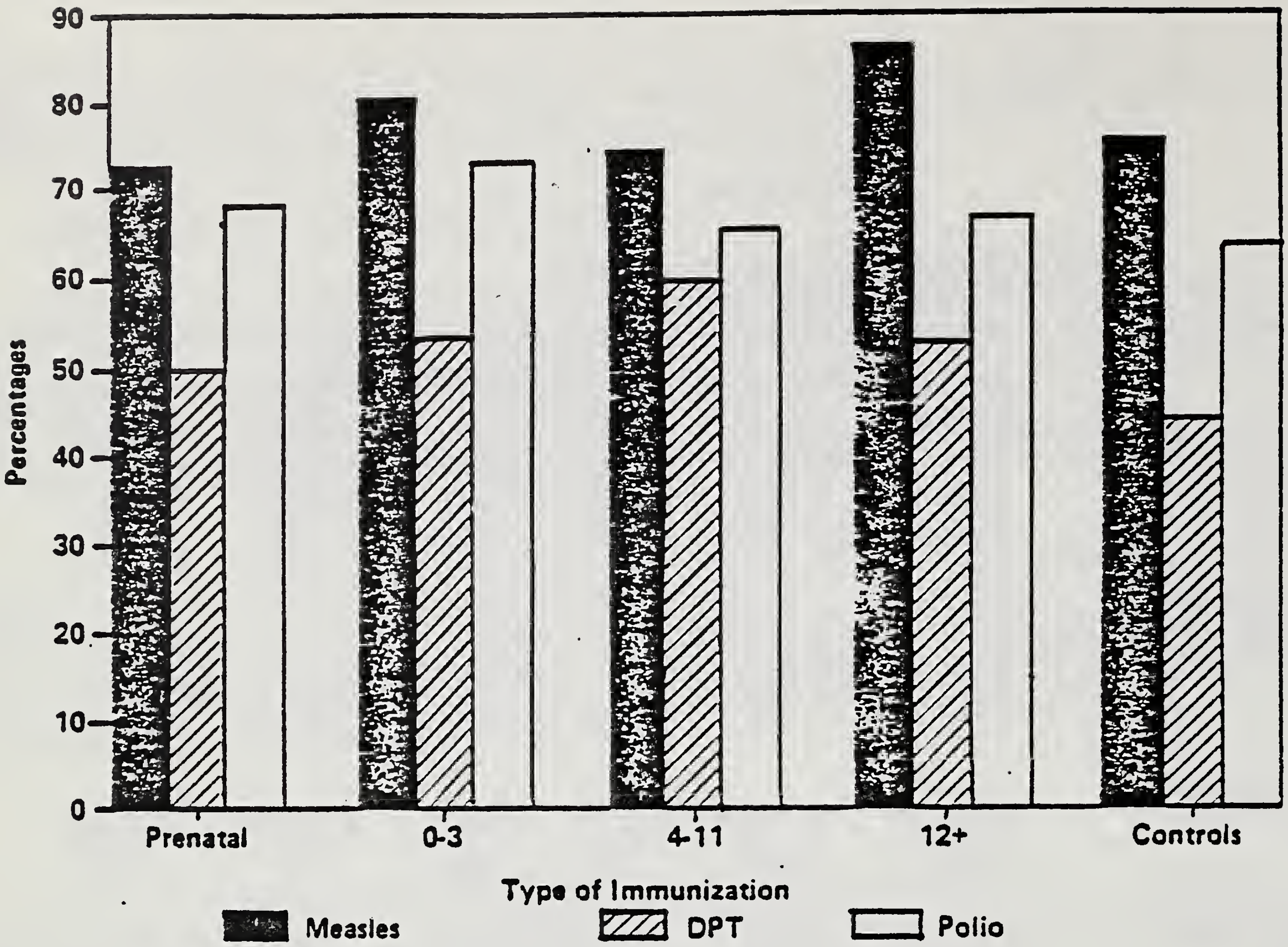


Figure VI-5. Proportion of children immunized.

Polio Vaccination. Sixty-seven percent of the study population was adequately vaccinated for polio. Those recruited into the WIC program in the first 3 months of life were 9.5 percent more likely to have adequate polio immunization than controls ($p < 0.05$) were; prenatal recruits also had a fairly substantial advantage (4.6 percent more likely than controls), but this difference was not significant.

4. Conclusions

Immunization status of WIC participants was better than that of control children as is summarized in Figure VI-5. This was particularly true for DPT immunization, but also for polio vaccination. Overall, the level of immunization in this population was not high, although greater than that found by the HANES Study. By the criteria used in this study, fewer than half of the studied children had adequate DPT immunization, two-thirds had adequate polio vaccination, and three-quarters (of those 15 months and older) had received measles vaccination.

No obvious confounding factors explain the effects of the WIC program such as differing health care practices across the country. A serious problem, however, is the directionality of the relationship between WIC and

immunization among postnatal recruits, a problem not solvable in this cross-sectional study. WIC benefits preceded health care among prenatal recruits, and improved care among them is consistent with beneficial program effects.

There is no evidence that the WIC program was related to the likelihood of mothers' breastfeeding, and evidence for promoting use of health services is uncertain. Increased use of a regular source of health care by WIC children recruited after birth could have been circular: the source of health care could have facilitated WIC program entry.

E. PSYCHOLOGICAL OUTCOMES

1. Introduction

The WIC program may affect the child's cognitive and behavioral development, in part through improved diet and health (GAO, 1984). However, the actual relationship between nutritional status in early human life (in utero or early childhood) and later behavior remains a matter of great controversy (for a detailed review of this issue, see Rush, 1984).

Possible conclusions from previous studies are tentative, at best. Some, but not all, studies found increased activity in infancy and early childhood following prenatal and/or early postnatal supplementation. In two studies, attentional processes appear to have been improved by prenatal supplementation, at 15 days (Vuori et al., 1979) and at 1 year of age (Rush et al., 1980a, 1980b). One study found differences in the Brazelton neonatal assessment scale associated with prenatal dietary supplementation (Osofsky, 1975) and another (Brazelton et al., 1977) did not. Cognitive changes have been observed infrequently and are of great uncertainty.

The most severe (but hardly the only) methodologic problem in these studies is to separate the effects on behavior of conditions that accompany nutritional deprivation or variability from the nutritional deprivation or variation. The summary experience in the human is most consistent with the conclusion that psychological deficits accompanying nutritional inadequacy are generally not the direct consequence of malnutrition. The evidence arises from several types of study. Severe infantile malnutrition caused by organic disease (pyloric stenosis, ileal atresia, or cystic fibrosis), presumably not of socio-behavioral etiology, has few, if any, long-term sequelae. Potentially devastating defects in mothering have been observed among mothers of "normal" infants who later became severely malnourished (Cravioto and DeLicardie, 1975). The defects in mothering could well have been the operational insult to these children's later behavioral deficit. Finally, several controlled trials of cognitive and behavioral enrichment following early childhood malnutrition have consistently shown major behavioral gains with stimulation and few or none with nutritional rehabilitation and health care alone (McKay et al., 1974; Grantham-McGregor et al., 1979; 1980; 1983). In sum, the relationship between nutritional status in early life and later behavior is unclear from current evidence.

Ideally, children in this study would have been evaluated in a centrally located, purposely designed setting by psychologists with professional credentials in child development. These psychologists would have used a wide array of standardized tests whose validity and appropriateness to the study of effects of nutrition on children's behavior and cognition had been confirmed. Such an ideal approach was well beyond the scope of this study.

The battery of tests used was chosen:

- To be maximally sensitive to differences in nutrition.

- For ease of reliable execution by previously inexperienced field workers in subjects' homes.

- Based on consultation with a panel of experts.

Behavior was assessed with Schaeffer and Edgerton's Infant Behavior Inventory (IBI) (1976), cognition with the Peabody Picture Vocabulary Test (Dunn and Dunn, 1981), and the forward and backward digit memory tasks from the McCarthy Scales of Infant Development (1972).

Indices were chosen specifically to address psychological issues arising from past work on nutrition and psychological development. The IBI addresses issues of attention and activity. The items on maternal response to testing are meant to assess mothers' interest in and concern for their children during testing. Digit memory was depressed in one of the studies of pyloric stenosis. Finally, the vocabulary test was chosen as a sensitive indicator of general cognitive performance that could be executed within the special constraints of this field study.

Given both the difficulty in testing and the relatively poor predictive validity from tests among younger children, behavior and cognition were assessed only in older preschool children. Thus, all 4-year-old index cases were included (n = 289). In addition, one randomly chosen 4- or 5-year-old older sibling of younger index children was assessed, if such an older sibling lived in the same household (n = 237). Because 5-year-olds are no longer eligible for WIC benefits, the relationships of current and past participation are presented only among 4-year-olds, though there were relatively few subjects.

Participation in the WIC program was specified by age at first program benefits, identical to assessment of somatic growth.

2. Analytic Methods

Child Behavior Scale

Creation of the Scale. Child behavior was assessed with Schaeffer and Edgerton's IBI (1976), which is composed of 42 items that were scored by the mother on a four-point scale. The IBI was constructed to yield 14 summary measures, each consisting of 3 items. Because the IBI was designed to be completed by teachers and at the advice of Schaeffer and Edgerton, it

was not assumed that the method of scoring for teachers would be applicable to responses by the mother. With the concurrence of the IBI's authors, the results of the mother's responses were subjected to factor analysis. The factor analyses were used to create and score summary behavioral measures that were then used as the dependent variables to judge the effects of WIC program enrollment.

Maximum likelihood factor analysis, followed by VARIMAX rotation, was applied to the responses for all 364 children with valid responses to all 42 items. A screen test suggested that either a four- or five-factor solution was optimal. The five-factor solution was chosen. It included constructs measuring the child's irritability and aggression and also overactivity and short attention span. One factor had both low-factor loadings (the highest was 0.38) and included disparate items (good natured, directing attention to a picture when asked, frequent switching of activity, easy to distract). This factor was omitted from these analyses. The four factors chosen included the following:

- Creativity/curiosity/determination/interest.
- Irritability/aggression.
- Overactivity/short attention.
- Isolation/ill-at-ease.

Each of these is discussed below.

Creativity/Curiosity/Determination/Interest--Nine items had loadings of over 0.50 on the factor (see below). The reliability of the scale, based on the nine items and measured by Cronbach's coefficient alpha, was 0.84.

Item	Factor loading
Shows strong interest in learning new things	0.742
Asks questions that show an interest in ideas	0.710
Has many ideas about interesting things to do	0.642
Is very good at paying attention to a single object or activity	0.631
Thinks of new ways to use materials	0.586
Says original and interesting things	0.583
Gets determined in doing something	0.564
Shows curiosity about many things	0.538
Is generally good-natured	0.536

Irritability/Aggression--The second factor included items on the child's irritability and aggression towards others. The five items with loadings over 0.50 all address the tendency of a child to act aggressively when frustrated. The reliability of the five-item scale was 0.79.

Item	Factor loading
Grabs what he wants and will hit and push to keep it.	0.718
Attacks others to get a toy.	0.659
Usually fusses and cries when he must give up something he wants to keep.	0.637
Is likely to throw a tantrum if he can't have his way.	0.553
Gets mad quickly if he can't do what he's trying to do.	0.547

Overactivity/Short Attention--This constellation of items is associated with the child's tendency to be continually active and have a short attention span. The reliability of the five items was 0.76.

Item	Factor loading
Must always be doing something.	0.705
Is very restless.	0.645
Is too active.	0.559
Switches from one activity to another frequently.	0.546
Easily loses interest.	0.530

Isolation/Ill-at-Ease--The fourth factor reflected the child's tendency to feel ill-at-ease with strangers present and to prefer being alone. The five-item scale measuring this factor had a reliability of 0.74.

Item	Factor loading
Stops talking and acts ill-at-ease around strangers.	0.633
Tries to stay out of sight when strangers are around.	0.627
Is uncomfortable with people.	0.591
Does not seek attention.	0.560
Prefers to be left alone.	0.553

Scoring of the Factors. Scores for each of the four constructs were computed by summing standardized item scores and dividing by the number of items so that each individual item contributed equally to the score. For subjects who did not have valid responses to all of the items of a scale, means were computed if at least half of the items were available. For example, if at least five of the nine items making up the creativity scale were available, these items were used to compute the score. If fewer than half the items were available, the construct score was considered missing.

(For computation, the mean score was multiplied by 10.) Because item scores were standardized, the mean of each item was zero, and the means of the factor-based scores were also very close to zero (except for slight deviations due to rounding errors). Reliability is, in part, a function of the number of items in a scale. Because some cases with less than complete data are included in analyses, the reliability coefficients are slight overestimates.

Correlations Among Scales. The intercorrelations among the four scales are presented below. The correlations are low, except for the correlation between irritability/aggression and overactivity/short attention (r = 0.53). The disattenuated correlation between these two constructs, based on the reliabilities of the two-factor-based scores, was 0.64, implying that about 41 percent of the variance in the two scales is common to both. The two separate factors were retained because of interest in differentiating the two types of behavior.

Correlations Among Scale Scores

	Creativity	Irritability	Overactivity
Irritability	-0.16		
Overactivity	-0.12	0.53	
Isolation	-0.22	0.24	0.12

Maternal Behavior Scale

The interviewer was asked to rate the mother's cooperation with the interviewer, responsiveness to the child's needs, and interest in the child's performance in the tests. These three items had high intercorrelations (see below). The items were included because of the observations of Cravioto and DeLicardie (1975) that mothers of infants later diagnosed as clinically malnourished were very much less interested in and supportive of their children during infant developmental evaluation.

Intercorrelations Among Maternal Behavior Items

	Cooperation	Responsiveness
Responsiveness	.68	
Interest	.50	.69

Given their high intercorrelation, the three items were combined by taking the mean of the standardized items when there were at least two valid responses. Scores were multipled by 10 for computation and the sign reversed, so that positive scores indicate positive ratings (more cooperative, responsive, and interested). The reliability of the scale is 0.82 and its mean is 0.16, with a standard deviation of 8.55. Maternal behavior was used as a covariate in the analyses of child cognitive measures.

Review and Scoring of Problem Peabody Picture Vocabulary Test Forms

One hundred and seven (20.9 percent) Peabody Picture Vocabulary Tests were jointly reviewed by project staff when the forms were unclear or otherwise problematic. Of these, 40 (8.8 percent) were clarified and scores given, 58 (12.8 percent) were coded as minimal scores and excluded from analysis, and 7 (1.5 percent) were coded as maximal scores and included in analysis. Only one form was considered unscorable.

3. Results

Introduction

The results and numbers of subjects studied are presented in Tables VI-19 and VI-20. The same set of covariates used in the full regression models and common to other analyses are used here, with the addition of maternal behavior for the cognitive measures. The regression analysis for the Peabody Picture Vocabulary Test is included in Appendix VI-E, Volume IV.

Participation in the WIC program was specified in these analyses as in the analysis of anthropometry. The key index of treatment was assumed to be the point in the life cycle when the child first began WIC benefits. Therefore, the population was stratified into those who began WIC benefits prenatally, during the first 3 months of life, during the rest of the first year, and after the first birthday. By far, the largest number of children began prenatally and the largest cells in all analyses were for controls and those whose initial WIC benefits began during their mother's pregnancy. The effect of duration of benefits was considered, as was the effect of current benefits (as in the dietary analysis) to address whether current WIC receipt might be important.

In the analyses by age of entry into WIC, there were three significant relationships. Each was at the $p < 0.05$ level.

The significant associations with WIC were that prenatal WIC recipients had better vocabulary scores, and recruits into WIC after the first year of life had significantly better backward digit memory and combined forward and backward digit memory.

It is important that these findings emerged only after the full adjustment for all covariates and were not present when results were adjusted only for the child's age and sex (see Volume IV, Appendix VI-E). In the anthropometric and dietary analyses there was moderately little modification of the observed results by controlling for the wide array of sociodemographic variables available. In other words, while the control group was more privileged than those who received WIC benefits, that difference in privilege was observed only to contribute minimally to the relationships of WIC with diet or anthropometry. The test of WIC benefits is therefore conservative, given that the population receiving WIC benefits was inherently less privileged than controls. The pattern of outcome for the psychological measures was very different. For instance, controlling only for age and sex, the vocabulary performance of prenatal WIC recipients was

Table VI-19
Psychological Measures by Age at WIC Inception[a]

	Age at WIC inception (mo)					
	Prenatal	0-3	4-11	12+	Unknown	Controls
Peabody Picture Vocabulary Test (raw score)	2.7552*	2.1503	2.8944	2.1747	4.3042	34.1488
n	160	33	17	54	17	172
Forward Numerical Memory Test	0.1042	0.3216	0.0993	0.5709	0.9496	5.3260
n	159	31	18	58	21	175
Backward Numerical Memory Test	0.0588	-0.1258	0.1252	0.6599*	0.6270	0.7028
n	137	25	16	42	16	143
Combined Forward and Backward Tests[b]	0.1049	0.3011	0.0663	1.0707*	1.3670	5.9578
n	144	25	16	44	16	150
Creativity/Curiosity Scale	0.8344	0.4410	0.2411	-1.8509	0.4587	-0.2616
n	170	30	17	57	17	182
Irritability/Aggression Scale	-1.1390	-1.4202	-0.2571	0.2643	-2.7086	0.3809
n	170	30	17	57	16	182
Overactivity/Short Attention Scale	-6.6265	-0.7434	1.4706	-0.6283	-1.8722	0.2981
n	172	31	17	59	19	188
Isolation/Ill-at-Ease Scale	-0.6873	-0.8034	-0.5057	-0.4280	0.1604	0.5220
n	170	30	17	57	16	182

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

[b]Child must have a backward score to have a combined score unless forward score <3, in which case the backward score was set to 0.

Table VI-20

Psychological Measures by Age at WIC Interception, Current WIC Status, and Age[a]

Age	WIC	Prenatal	0-3 mo	4-11 mo	12+ mo	Unknown	Controls
		PEABODY PICTURE VOCABULARY TEST (RAW SCORE)					
	Current	3.12	-3.88	14.02*	4.15	0.85	
	n	36	4	3	10	2	
4							34.57
							118 = n
	Past	2.92	5.21	-2.63	-0.45	6.22	
	n	86	21	8	18	10	
5	Past	2.06	-2.26	4.59	-2.82	1.73	34.22
	n	38	8	6	26	5	54 = n
		FORWARD NUMERICAL MEMORY TEST					
	Current	0.39	-0.30	1.46	0.63	4.78**	
	n	38	4	4	12	2	
4							5.36
							120 = n
	Past	-0.01	0.49	-0.38	0.66	0.98	
	n	83	20	8	19	12	
5	Past	0.13	0.25	-0.34	0.44	-0.31	5.35
	n	38	7	6	27	7	55 = n
		BACKWARD NUMERICAL MEMORY TEST					
	Current	0.43	0.26	1.03	1.00	-1.08	
	n	34	4	2	9	1	
4							0.46
							90 = n
	Past	0.20	0.06	0.05	0.66	1.52**	
	n	65	15	8	11	9	
5	Past	-0.41	-0.69	-0.16	0.39	-0.50	1.17
	n	38	6	6	22	6	53 = n

See footnotes at end of table. (continued)

Table VI-20 (continued)

Age	WIC	Prenatal	0-3 mo	4-11 mo	12+ mo	Unknown	Controls
		COMBINED FORWARD AND BACKWARD TESTS[b]					
	Current	0.87	0.05	2.48	1.18	1.74	
	n	35	4	2	9	1	
4							5.70 97 = n
	Past	0.09	0.58	-0.32	1.51	2.62*	
	n	72	15	8	12	9	
5	Past	-0.40	-0.06	-0.42	0.66	-0.75	6.47
	n	37	6	6	23	6	53 = n
		CREATIVITY/CURIOSITY SCALE					
	Current	0.80	-3.09	0.89	-0.96	0.72	
	n	38	4	4	12	2	
4							-59.87 132 = n
	Past	0.50	0.94	-0.25	-4.49**	-0.64	
	n	93	19	8	22	9	
5	Past	1.29	0.84	0.79	0.18	1.98	-58.00
	n	39	7	5	23	5	57 = n
		IRRITABILITY/AGGRESSION SCALE					
	Current	2.05	-0.94	1.54	1.75	4.70	
	n	38	4	4	12	2	
4							19.56 125 = n
	Past	-1.65	-1.63	1.24	-0.34	-1.48	
		93	19	8	22	9	
5	Past	-2.29	-0.81	-4.10	-0.09	-8.20	18.63
	n	39	7	5	23	5	57 = n

See footnotes at end of table. (continued)

Table VI-20 (continued)

Age	WIC	Prenatal	0-3 mo	4-11 mo	12+ mo	Unknown	Controls
		OVERACTIVITY/SHORT ATTENTION SCALE					
	Current	-1.78	1.54	1.42	0.81	4.01	
	n	39	7	4	12	2	
4							-0.70[c]
							130 = n
	Past	-1.25	-2.62	3.18	-1.92	-1.82	
	n	94	19	8	22	11	
5	Past	1.99	2.35	-1.21	0.27	-4.15	-4.98[d]
	n	39	8	5	25	6	58 = n
		ISOLATION/ILL-AT-EASE SCALE					
	Current	-0.69	-6.91	-0.83	-1.69	0.81	
	n	38	4	4	12	2	
4							59.53
							125 = n
	Past	-1.09	1.51	2.88	-0.51	0.06	
	n	93	19	8	22	10	
5	Past	-0.01	-3.71	-5.54	0.18	0.11	56.77
	n	39	7	5	23	4	57 = n

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a] All values result from a regression model that controls for a full set of covariates. (See Table VI-1 for full covariate list.) Values are differences from the control group means by current or past receipt of WIC benefits.

[b] Child must have a backward score to have a combined score unless forward score <3, in which case the backward score was set to 0.

[c] Mean and n for all 4-year-old control children.

[d] Mean and n for all 5-year old control children.

worse than that of controls, and a significant increment in favor of the prenatal recipients emerged only from the full regression model. Thus, the characteristics that differentiated WIC recipients and controls were such that they affected child cognitive performance, and what is interpreted as a real difference (whether etiologically related to WIC or not) was suppressed in the raw analysis and only emerged after controlling for a variety of differences between the study groups.

Peabody Picture Vocabulary Test

Of all the tests, the vocabulary test is probably the most sensitive to differences in social status and it is the one in which the full regression model most dramatically changed the relationship to WIC. For those recruited into WIC after 12 months of age, the change from the age- and sex-controlled model to the fully controlled model was miniscule (from raw score difference of 2.0 to 2.2 units); for prenatal recruits, the change was from a raw score difference of -0.7 units to +2.8 units. This indicates that the late recruits were more privileged than earlier recruits and were more like controls socially than recruits under 1 year of age.

It is confusing that the magnitude of positive difference, varying between 2.2 and 2.9 raw score units, was about the same independent of the age when WIC benefits were begun. Thus, while the results are in part consistent with the hypothesis that early exposure to the WIC program had greater effects than later exposure since only the relationship with early exposure was statistically significant, the equal magnitudes of effect are more consistent with either an effect of WIC benefits at any time in the life cycle or with current benefits, independent of recruitment age. The results in Table VI-20 suggest that effects of WIC are not due to current benefits.

Digit Memory

The other significant relationship with WIC was among those recruited after the first year of age, who did significantly better than controls on backward digit memory (and a combined index that included backward digit memory, see Table VI-19). They also did better in forward digit memory, but that difference was not significant. Those recruited into WIC earlier in life appeared to do no differently than controls on these digit memory tasks. While these results suggest the possibility that effects were due to current WIC benefits (the relatively flat relationship of the increment in the Peabody Vocabulary score with age when WIC benefits were begun and the significant positive relationship in backward digit span among most recent recruits), when the results were studied by current receipt of WIC (see Table VI-20), there was no evidence that current benefits were responsible for the significant results.

Child Behavior

There were no significant relationships of any of the four behavior factors to WIC benefits. Again, while patterns suggested that current WIC

benefits might be more related to behavior than age of starting WIC benefits, subsequent analyses (see Table VI-20) failed to support this possibility. Except for the tiny group of children recruited into the WIC program between the ages of 4 and 11 months (n = 17), there is a consistent but not significant relationship of WIC benefits with lower activity levels of about the same magnitude and independent of when the child was recruited into the program. On the other hand, the magnitude of differences associated with WIC is about the same as for the index of isolation, for which there is no expectation of any relationship with nutritional supplementation.

These results imply the need for expanded research to better judge whether WIC benefits were related to child cognition and behavior. The best source of answers to some of these important questions may be by continued followup of the cohort of children born into the Longitudinal Study of Pregnant Women.

VII. THE FOOD EXPENDITURES STUDY*

A. INTRODUCTION

The objective of this component of The National WIC Evaluation is to investigate the extent to which the WIC food package is used to supplement the diet of the WIC recipient. Previous experience with food assistance programs indicates that substantial "leakage" occurs. That is, there is a difference between the value of supplemental food assistance and the value of increased food intake of the intended recipient (Basiotis et al., 1983; Smallwood and Blaylock, 1983). This leakage consists of two different components: a sharing component due to sharing of the supplemental food with other family members, and a substitution component due to displacement of food that otherwise would have been purchased and consumed by the recipient.

In The National WIC Evaluation, substitution and sharing have been distinguished as follows: The WIC recipient receives a WIC food instrument that allows the family to purchase specific foods. If the total increase in food expenditures equals the value of the WIC package, no substitution has occurred. If the family increases its food expenditures by the value of the WIC package and if the extra food is consumed by other family members as well as the designated WIC recipient, the food has been shared. The amount of sharing equals the increased food consumption by family members other than the WIC recipient. Alternatively, if food expenditures do not increase and if the recipient does not increase her consumption of designated WIC foods, substitution has occurred and the WIC package has allowed the family to increase its consumption of goods other than WIC foods.

The behavior of families with respect to expenditures and consumption of WIC foods and other goods and services in response to receipt of WIC benefits is more complex and variable than in the examples. Additional food may be purchased, but consumption may not increase, due either to wastage or to purchase of more expensive foods. On the other hand, the family may not increase its food expenditures but could improve its consumption patterns because of nutrition education or food purchase information received from the WIC program, leading to more efficient food expenditures.

The ideal study of the response to the introduction of the WIC package would use a combination of consumer expenditures and consumption studies. A detailed consumer expenditures study would measure expenditures for food in general, WIC foods, and nonfood items conducted before and after introduction of the WIC package. This would allow for the specification of the amount and kind of substitution. A detailed food consumption study that measured food consumption of all family members pre- and post-WIC would permit both specification of the amount of sharing and identification of the type of family members with whom WIC foods are shared. Combined information on expenditures and consumption also would allow wastage to be

*This chapter was prepared by Research Triangle Institute staff.

identified. In addition, an ideal study would compare WIC and non-WIC families for both the woman, infant, and child components of the program because in each case the demand for food and other goods within the family would be different.

An ideal study was not possible within the Longitudinal Study because providing both detailed consumer expenditures data and family-level consumption data would be too burdensome, given other data collection requirements. Thus, the Food Expenditures Study did not use food consumption data. Instead, it used recalls of food expenditures for the month prior to interview in each of the two interviews conducted with pregnant women in the Longitudinal Study. The lack of food consumption data introduced to the study some limitations that are discussed below.

B. DATA COLLECTION DESIGN AND METHODS

The study combined the use of recall and diary methods to collect household food expenditures, thus permitting longitudinal and cross-sectional comparisons between WIC and non-WIC households. A description of the survey instruments is given in Volume IV, Appendix VII-A. The study sample was the nationally representative probability sample of pregnant women enrolled in WIC and the control group of pregnant women in the Longitudinal Study of Pregnant Women. The sample design is discussed fully in Chapter IV.

Data collection proceeded as follows: during the initial clinic enrollment interview, all WIC and non-WIC women were asked to specify by recall their average monthly expenditures for food and beverages for the month immediately preceding the interview. This is referred to as "Time 1" in the following discussion. The questions used were comparable to those previously developed and used in the U.S. Quarterly Consumer Expenditure Surveys and by Statistics Canada. These questions were repeated during the second interview late in the pregnancy ("Time 2"), along with a question about whether or not food expenditures had increased, decreased, or remained constant since the first interview.

At the second interview, in addition to this recall assessment of food expenditures, a random sample of approximately 920 WIC and 850 non-WIC women was asked to keep a diary of their detailed food purchases for a 1-week period following the visit, using a ledger-type diary similar to those employed in the U.S. Consumer Expenditure Surveys and in the Canadian Family Food Expenditure Surveys. A portion of the second interview was devoted to instruction and demonstration on the use of the Diary, an incentive was offered for participation in this phase of the study, and an interviewer collected the Diary in a home visit in order to encourage a high level of cooperation and complete reporting in these Diaries. During the home visit, the interviewer thoroughly checked the Diary for consistency and completeness, using a set of "diary check" questions for types of expenses typically forgotten, and attempted to obtain by retrospective interview information for days not recorded in the Diary.

Because diary information was collected only at the time of the second interview, a longitudinal analysis based on these data is not possible. However, the data are especially useful for comparing WIC and non-WIC households because of the greater detail they provide about the types of foods purchased. Specifically, diary data may be used to examine potential program impact related to changes in food purchasing behavior by comparing WIC and non-WIC diary-keeping families in terms of the portion of the food dollars allocated to various types of food.

There are limitations to the inferences that can be made from this study. The study emphasizes the impact on pregnant women participating in the WIC program. As are all survey data, the data collected are subject to measurement errors and, to the extent that the families could not accurately report either their income or their food purchases, findings may be biased. The analytic strategy employed attempts to make the best possible use of the data obtained, but the results are limited by the sample sizes available for the analyses.

The use of recall and diary methods was intended to test the effects of WIC on food expenditures and on the use of WIC-type foods. These two methods, however, cannot be used to crosscheck dietary consumption information. The use of recall methods is a proven cost-effective way of gathering information about food purchasing patterns, closely approximating actual average intake over a predefined time period (Adelson, 1960; Burk and Pao, 1976) albeit with a possibility for underestimating actual consumption (Madden et al., 1976) or overestimating actual food expenditures (Quackenbush and Schaeffer, 1960).

Diary methods, on the other hand, tend to be more costly but yield more detailed data about intake by food groups. However, they also have their biases. In methodological comparisons among diary and recall methods, Burk and Pao (1976) found that diary estimates differed substantially from the other methods. Correlation coefficients among diary and recall methods were relatively low, about 0.69 on the average (Balogh et al., 1971). In general, diary records are not representative of average long-term intake due to weekly fluctuations in the family's purchasing patterns (payday effect), recording inaccuracies, or diary-induced modifications in the types of foods consumed by the family (Burk and Pao, 1976). The correlation between diary and recall data to measure food expenditures in this study is approximately 0.49, which is consistent with the above findings.

Despite the shortcomings outlined above, diary and recall methods remain the most cost-effective ways to collect data on food purchasing from large samples. Along with intake and expenditures data, major predictors or correlates of family food expenditures such as family size, age-sex household composition, and household income were collected. Usable data on food expenditures based on recall information were collected from 4,219 WIC women and 785 non-WIC women at Time 1 and Time 2. The numbers completing the Food Purchase Diary were 1,031 WIC women and 551 non-WIC women. It should be noted that women who initially had been selected into the sample

as controls but who later were enrolled in WIC were included with the initial WIC women in the data analysis. The numbers of cases shown here with usable recall and diary data reflect the switchovers of control cases to WIC cases.

C. ESTIMATION PROCEDURE

1. Analytical Model

This study represents the first econometric estimation of WIC's impact on food expenditures. Accordingly, estimation methods developed here draw heavily on those used in similar nutritional assistance programs such as the Food Stamp and the National School Lunch Programs (Basiotis et al., 1983; Akin et al., 1983; Chen, 1983; Basiotis, 1983). However, these methods have been modified to account for the separate effects of substitution and sharing. Total substitution and sharing from the WIC program for a given household are defined as the difference between the amount of food transferred to WIC recipients in the household and the increase in their consumption of these foods. Substitution is defined as the tendency for WIC recipients to exchange directly or indirectly the foods obtained from WIC for other types of food or for nonfood items. Sharing is defined as the tendency for WIC recipients to share foods from the WIC transfer with other household members. The net effect of substitution and sharing is a reduction in the intended impact of the WIC program on the intake of WIC foods and WIC-type foods by the WIC participant.

The accumulated experience of other food assistance programs indicates that a fraction of the value of food assistance is diverted by the family to purchase other goods. For Food Stamps, this fraction is significant in size and may account for 50 to 90 percent of total food assistance. This is called substitution leakage. For WIC, however, where food assistance is "in kind" and specifically targeted to pregnant women, infants, and children, substitution may be very different from substitution observed with Food Stamps, and some sharing may occur as well.

If data on consumption of specific food items by individual household members and data on varying prices of specific food items were available, demand functions for all types of household members could be estimated (see Volume IV, Appendix VII-C). This approach would be fully consistent with demand theory, and the results would therefore be more directly comparable with other results reported in the literature on consumer demand for food. Without such data, the following approach may be used.

Food expenditures at Time 2 may be modeled as:

$$FE_2 = g + h_1\hat{FE}_1 + h_2D + h_3N_c + h_4N_a + h_5DN_c + h_6DN_a + \ell X + u$$

where

g = an intercept

h_i = a regression coefficient ($i = 1...6$)

$\hat{FE}_1$ = food expenditures at Time 1

N_c = the number of children

N_a = the number of non-WIC adults in the house

D = a dummy variable that takes the value of 1 if the woman is a recipient of the WIC package and 0 if she is not

X = a vector of socioeconomic characteristics at Time 2

ℓ = a vector of coefficients associated with X

u = an error term.

This equation allows an evaluation of the impact of the WIC program as follows. The coefficient h_2 will measure the impact of the woman's joining the WIC program on total household food expenditures. The coefficients h_5 and h_6 measure the impact of each extra child and adult, respectively, on expenditures when the woman is a WIC recipient to adjust for sharing. The coefficients h_3 and h_4 measure the effect of an extra child or adult on expenditures under usual circumstances. It is to be expected that h_3 and h_4 would be rather large and statistically significant since household size is known to be a main determinant of household food expenditures. Coefficients h_5 and h_6 would be expected to be statistically significant only if the woman is a WIC recipient and she affects other adults' and children's impact on total family food expenditures over and above normal circumstances. Thus:

$$\text{Sharing} = h_5 + h_6.$$

Because h_2 is the measure of the WIC program's intended impact, substitution must equal the total WIC transfer, W, minus intended impact, minus sharing. Thus:

$$\text{Substitution} = W - (h_2 + h_5 + h_6).$$

Therefore:

Total leakage = sharing + substitution = $W - h_2$, or the value of the WIC transfer minus its intended impact.

Note the importance of including FE_1 in the equation for FE_2. If, for example, families of WIC recipients tended to spend more on food than other families (for any reason) and FE_1 were not included in the equation for FE_2, the preexisting difference in expenditures levels between WIC recipients and other families would be attributed improperly to the WIC program. Thus, FE_1 can be used to "adjust" for any preexisting differences. However, the use of FE_1 introduces a problem with estimating the FE_2 equation via the ordinary least-squares method. In most cases FE_1 would include a

measurement error correlated with the measurement error for FE_2, so ordinary least-squares estimation of the equation for FE_2 would be biased. Therefore, a two-stage method is used, estimating first an equation for FE_1 and using the predicted value of FE_1 in the second stage as an independent variable in the equation for FE_2. The rationale for this method is described in detail in Volume IV, Appendix VII-C.

2. Definition of Variables

Three types of variables are important for this analysis. The first type of variable corresponds to the family's food and nonfood expenditures. Food expenditures are defined as the sum of all reported expenditures on foods reported in Time 1 and 2 interviews. The second type of variable is income. Total income is defined as the sum of income received from wages and from nonwage sources such as Food Stamps and other family assistance programs. Participation in the National School Lunch Program by children is considered an adjustment factor because differences may exist between Time 1 and Time 2 in benefits received from these programs. In addition, multiple WIC packages (infant, child, or woman) may be available to the family, and this availability may vary from Time 1 to Time 2 interviews. The third type of variable employed corresponds to the socioeconomic vector X. The socioeconomic vector is composed of a series of variables that have been found to be significant in similar studies (Adrian and Daniel, 1976; Blaylock and Smallwood, 1981). These variables include:

- Age-sex composition of the household. Family composition is classified according to family member's age and sex to account for the different nutritional requirements found among them.

- Ethnic group. Dummy variables with a value of 1 if respondent belongs to any of the following groups: EG1 = white, EG2 = black, and EG3 = Hispanic.

- Education of WIC woman. Dummy variables with a value of 1 if respondent completed any of the following groups: ED1 = elementary school, ED2 = high school, ED3 = junior high school, and ED4 = post-high school.

- Home ownership. Dummy variable with a value of 1 if family owns the home it lives in and a value of 0 otherwise.

- Civil status. Dummy variable with a value of 1 if a male head is present and a value of 0 otherwise.

3. Sample Characteristics

The study's basic sample population is comprised of 4,219 WIC participants and 785 non-WIC participants. From this sample, a subsample of 1,031 WIC women and 551 non-WIC women was obtained for the diary data on food purchases. Characteristics of these samples are summarized in Tables VII-1 and VII-2, with standard errors in parentheses. The standard errors are

Table VII-1

Selected Socioeconomic Characteristics of WIC and Non-WIC Families

Variables	WIC n = 4,219				Non-WIC n = 785			
	Time 1		Time 2		Time 1		Time 2	
Total family income ($/month)	582.04	(6.29)	--		739.38	(19.96)	--	
Total food expenditures ($/month)	199.77	(1.92)	210.04	(1.92)	213.98	(4.67)	223.15	(5.10)
Grocery expenditures ($/month)	160.64	(1.42)	170.67	(1.44)	166.12	(3.37)	171.21	(3.53)
Meals away from home ($/month)	11.73	(0.37)	12.37	(0.37)	21.91	(0.98)	21.19	(0.98)
Food Stamps ($/month)	66.56	(1.43)	70.02	(1.42)	34.44	(2.48)	35.36	(2.44)
Number of children (1-5 years of age)	0.63	(0.01)	--		0.55	(0.03)	--	
Number of other family members including WIC women)	1.98	(0.03)	--		1.89	(0.05)	--	
Ethnicity (% of total)								
Whites	49.08	(0.77)	--		56.90	(1.77)	--	
Blacks	31.19	(0.71)	--		19.20	(1.40)	--	
Hispanics	17.91	(0.59)	--		21.40	(1.46)	--	
Education of women (% of sample)								
1-6 years	4.17	(0.31)	--		1.52	(0.44)	--	
7-8 years	8.22	(0.42)	--		6.11	(0.86)	--	
9-11 years	42.87	(0.76)	--		34.52	(1.70)	--	
12 years or more	34.13	(0.73)	--		42.54	(1.77)	--	
Home ownership (% of sample)	19.62	(0.61)	--		19.49	(1.41)	--	

Notes: -- indicates not measured; standard errors of means are in parentheses.

Source: Food Expenditures Recall Sample.

Table VII-2

Selected Socioeconomic Characteristics of WIC and Non-WIC Families

Variables	WIC n = 1,031		Non-WIC n = 551	
Total income for diary week ($)	140.75	(3.16)	175.06	(4.38)
Number of children 1-5	0.61	(0.02)	0.54	(0.03)
Number of other family members (including WIC women)	1.95	(0.05)	1.87	(0.06)
Food Stamps ($/week)	16.30	(0.64)	7.94	(0.65)
Ethnicity (% of sample)				
Whites	50.72	(1.56)	56.98	(2.11)
Blacks	29.00	(1.41)	17.60	(1.62)
Hispanics	18.52	(1.21)	23.41	(1.81)
Education of women (% of sample)				
1-6 years	3.29	(0.56)	1.63	(0.54)
7-8 years	8.34	(0.86)	5.08	(0.93)
9-11 years	43.45	(1.54)	34.66	(2.02)
12 or more years	33.36	(1.46)	43.01	(2.11)
Expenditures by food group ($/week)				
WIC-type foods[a]	12.76	(0.38)	8.13	(0.26)
Meat	15.27	(0.51)	15.11	(0.75)
Condiments	6.09	(0.21)	6.00	(0.26)
Cereals and breads	6.86	(0.18)	7.14	(0.23)
Fresh foods (e.g., fresh fruits)	20.35	(0.59)	21.15	(0.79)
Frozen foods (e.g., frozen vegetables)	4.14	(0.24)	3.58	(0.24)
Vegetables (neither fresh nor frozen)	7.65	(0.24)	7.11	(0.29)
Dairy	1.59	(0.10)	1.46	(0.08)
Beverages	4.09	(0.14)	4.07	(0.19)
Others	0.09	(0.01)	0.10	(0.02)
Total food expenditures ($/week)	64.06	(1.33)	62.85	(1.68)
Grocery expenditures ($/week)	54.44	(1.21)	49.15	(1.52)
Meals away from home ($/week)	9.61	(0.38)	13.69	(0.69)

Note: Standard errors of means are in parentheses.

[a]The term WIC-type foods refers to all foods contained in the WIC package plus the same type of foods purchased with the family's own funds. For a listing of the foods contained in the WIC package, see Volume II, Chapter 1.

Source: Food Purchase Diary Sample.

provided to make it easier for the reader to judge the significance of the differences between means for the variables presented in the tables.

In general, non-WIC families seem to be economically more viable than WIC families. Total family income is higher for non-WIC families, and education levels and racial distribution differ. Non-WIC families tend to be better educated with a higher proportion of pregnant women having high school educations than those in WIC families. The proportion of whites among non-WIC families is higher than among WIC families while a larger proportion of WIC families than non-WIC families is black. Finally, WIC families also receive about twice as much in Food Stamps as do non-WIC families.

The WIC families in the recall sample reported significantly less total food expenditures than the non-WIC families. They spent significantly less on meals away from home, but more on Food Stamp purchases than the non-WIC families (see Table VII-1). The WIC families in the diary sample reported significantly greater grocery expenditures and purchases of WIC-type foods than non-WIC families in Time 2. There were no significant differences between the two family groups in expenditures on any of the other food categories, however. Expenditures on meals away from home were also significantly less for the WIC diary sample families (see Table VII-2).

The higher expenditure levels for WIC foods found among WIC families cannot be attributed automatically to program participation since no diary measures exist at Time 1 prior to initial enrollment in the WIC program.

D. RESULTS

The results indicate that the WIC program's effect on total family food expenditures is very small. However, the program's effect on the WIC woman's use of WIC-type foods is positive and statistically significant. In addition, in terms of food expenditures, the value of the WIC package seems to be totally substituted for goods other than food. In other words, the value of the term defined as substitution is statistically equal to the value of the WIC package. And, given that there is no evidence that the WIC food package supplements family food expenditures, there is no meaningful statistical measure of package sharing.

1. Substitution and Sharing

The econometric results from the expenditures recall data indicate that food expenditures increases that could be attributed to participation in the WIC program were undetectable. Table VII-3 presents the second stage of the two-stage econometric model that accounts explicitly for the coefficients measuring substitution and sharing. As the first column of Table VII-3 shows, the WIC coefficients for total food expenditures and grocery expenditures are not significantly different from zero, indicating no apparent increase in food expenditures that are attributed exclusively

Table VII-3

Impact of WIC Participation on Monthly Food Expenditures[a]

Selected independent variables	Dependent variables ($/month): Total food expenditures	Grocery expenditures	Meals away from home
Intercept	136.08***	109.35***	11.71***
Estimated expenditures (Time 1) (h_1)	0.16***	0.12***	0.51***
Children (h_3)	27.79***	24.91***	- 1.18
Adults (h_4)	41.19***	28.53***	2.90***
WIC (h_2)	- 9.59	- 3.90	- 5.16***
WIC*children (h_5)	- 6.83	- 7.05	1.09
WIC*adults (h_6)	-10.37***	- 3.08	- 1.86*
Lunch program	- 0.02	- 0.08	0.04
Guests	16.62***	17.45***	- 1.88
Food Stamps	0.10***	0.12***	- 0.03***
Other WIC women	7.12	1.55	1.28
WIC infant (1-12 months)	-15.59	- 8.80	0.36
WIC child (1-5 years)	6.63	7.75*	- 0.04

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Complete table is shown in Volume IV, Appendix VII-B.

Source: Food Expenditures Recall Sample.

to the WIC woman. Furthermore, the value of the sharing component is either negative or insignificant. Because the sum of the coefficients $h_2 + h_5 + h_6$ is never positive, the value of substitution is at least equal to W, the value of the WIC package.

In terms of sharing, the results on total food expenditures show that the WIC*children coefficient is not different from zero indicating that WIC women do not share WIC foods with their children. However, the interaction term, WIC*adults, which measures sharing with the adult members of the family, is negative and highly significant. In other words, the presence of other adults in a WIC household appears to reduce monthly total food expenditures by $10.37. Grocery expenditures must be examined to interpret this result fully.

The results for grocery expenditures (second column, Table VII-3) show a pattern similar to that for total food expenditures. The interaction term of WIC with other adult family members, however, is quite a bit small-

er and insignificant. Hence, in the grocery expenditures equation the sum of the coefficients $h_2 + h_5 + h_6$ is not different from zero, which yields a value of substitution equal to the value of the WIC package. Because the difference between total food expenditures and grocery expenditures is mostly explained by expenditures on meals away from home, the significant interaction effect h_6 observed for total food expenditures may be explained by the effect of WIC on meals eaten out.

The results of regressing expenditures on meals away from home on the model's variables confirm the previous assertion that the value of sharing is zero. The third column of Table VII-3 shows that WIC program participation is strongly associated with a tendency to spend less on meals away from home. Families of pregnant women participating in WIC are estimated to spend $5.16 less per month on meals eaten out than the families of non-WIC women. Moreover, families with a WIC woman and one additional adult spend $7.02 less on meals away from home than non-WIC families. Hence, these results indicate that the negative and significant interaction coefficient in the total food expenditures equation was due to "reverse sharing" brought about by the savings on meals away from home induced by WIC participation. This estimate also suggests that WIC program participation contributes to a larger proportion of home-cooked meals in the family diet. Because meals away from home have an implicit cost for service and therefore tend to be more expensive per unit of nutrients than home-cooked meals, the WIC program fosters a more efficient use of the family's food budget.

The results from the food expenditures recall data therefore suggest that substitution accounts for the entire value of the WIC package and that sharing is statistically nonexistent. These findings, however, do not imply that the WIC program has no impact. The findings on substitution and sharing examine program impact only in terms of food expenditures which only partially indicate program performance. It is entirely possible, for example, to have totally different food consumption patterns between two time periods and still have data showing equal food expenditures. It is necessary to examine the impact of the WIC program on both food expenditures and food purchase patterns in order to view the economic impact of the WIC program from a more complete perspective and to add more information to the issue of food substitution and sharing.

2. <u>Impact of WIC on Food Expenditures Patterns</u>

The economic impact of the WIC program may be measured through close examination of total food expenditures and food purchase patterns. The former gives a clue to the variables affecting the family's budgetary allocation for food, while the latter shows how this allocation is spent among the different food groups. Presumably, a nutritional assistance program that generates demand for more nourishing foods is deemed more successful than one that fails to do so.

From the data on total food expenditures, the results summarized in Table VII-3 indicate that the household composition is the primary determinant of total food expenditures. For every additional adult in the household food expenditures increase an average of $41 a month; for every child

this expense increases $28 a month. Moreover, for each additional guest residing in the household total monthly food expenditures increase by almost $17. The effect of food assistance on total food expenditures, which include the cost of all food consumed regardless of origin, also may be obtained from Table VII-3. Food Stamps have a small but significant effect on food expenditures. For every additional dollar received in terms of Food Stamps, grocery expenditures increase approximately 12 cents. This value is similar to those reported in other studies (Chen, 1983; Basiotis, 1983). For grocery expenditures, the model coefficients are generally consistent with the total food expenditures equation although of a lower magnitude. An exception to this rule is the value for the WIC children coefficient, which indicates that for every WIC child in the household, monthly grocery expenditures increase by almost $8.

Table VII-4 presents the statistical results from the diary data analysis. The table is divided into several columns representing the different food groups reported in the diary. These food groups in turn represent components of the market basket with declining degrees of importance based on nutritional value and program objectives. The fourth column shows the regression results for food normally found in the WIC package, with significant coefficients for income (not shown) and family composition. What is important in this equation, however, is the coefficient for the WIC variable, which is positive and highly significant. This coefficient indicates that WIC women spend $2.54 more per week on WIC-type foods than do non-WIC women. Moreover, coefficients for the interaction terms, which measure sharing, are nonsignificant and therefore interpretable as not different from zero. In addition, the WIC foods equation indicates that WIC children under 5 years of age receive $2.25 more WIC-type foods than non-WIC children in the same age group. This finding is consistent with evidence obtained from the recall data, which show significant positive effects of the WIC children's component.

A second important finding is the effect of WIC participation by children on grocery expenditures. Consistent with the recall data, the diary data show that WIC children under 5 years of age, account for $6.06 of grocery expenditures per week.

The third important finding of the diary data analysis in relation to the WIC program is the insignificance of the WIC coefficient in the equations explaining expenditures in other food groups. This lack of significance clearly indicates that the conceptual model is internally consistent and sufficient to detect program impact.

The results for the other food groups show some general trends that are fairly easy to interpret. Expenditures on meats, for example, primarily depend on the presence of adults in the household. Overall, the effect of the family's age-sex composition is the predominant force explaining food group expenditures. Food Stamps account for a very modest but significant effect on expenditures that is consistent with the recall analysis and findings from other similar studies.

Table VII-4

Impact of WIC on Types of Food Purchased and on Types of Food Expenditures ($/Week)[a]

					Non-WIC foods				
Selected independent variables	Total expenditures	Grocery expenditures	Meals away	WIC-type foods	Meats	Cereals and bakery	Vegetables	Fresh foods	Frozen foods
Intercept	62.15***	52.13***	10.03***	8.46***	16.85	8.92***	9.79***	25.32***	6.17***
Male head present	-7.27**	-6.98***	-0.30	-1.66**	-1.96*	-1.60***	-1.18**	-2.78**	-0.84*
Children 0-5 years old	1.04	2.12	-1.08	1.07	0.03	0.51	-0.02	0.15	-0.18
Adults	8.14***	7.10***	1.04**	1.14***	2.35***	1.23***	0.87***	3.66***	0.25
WIC	-3.34	0.75	-4.10***	2.54***	-1.25	-0.77	0.50	-1.24	-0.28
WIC*children	2.21	0.59	1.61	0.82	0.55	-0.38	-0.03	0.28	0.16
WIC*adults	0.20	-0.06	0.27	0.44	-0.23	-0.06	-0.08	-0.71	0.27
Lunch program	0.29	0.37*	-0.08	0.03	0.10	0.04	0.03	0.14	0.04
Guests	4.79**	3.47*	1.32*	0.33	0.73	0.80	0.48	1.38	0.15
Food Stamps	-0.13*	-0.04	-0.08***	-0.01	0.02	0.00	-0.03**	-0.03	-0.00
Other WIC women	4.38	3.98	0.49	1.23	0.79	0.65	0.46	0.27	0.60
WIC children 0-5 years old	5.89*	5.82*	0.06	2.25**	0.29	0.95**	0.32	-0.05	0.81

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]For complete tables and remaining food groups, see Volume IV, Appendix VII-B.

Source: Food Purchase Diary Sample.

The fourth and final important finding from the diary data analysis relates to expenditures on meals away from home. Consistent with findings from the recall data, which show no significant WIC impact on total food expenditures but a strong negative association with expenditures on meals away from home, results of the diary analysis indicate the same basic pattern. As the column labeled "Meals Away" shows, the WIC coefficient is negative and highly significant, with an effect even stronger than that observed in the recall data. Program participation, as indicated by the WIC coefficient, is associated with reduced expenditures for meals away from home of more than $4 a week. As explained previously, this probably accounts for greater efficiency in the use of the family budget and is apparently attributable to WIC participation.

3. Change Score Analysis and Other Alternative Models

An additional way to analyze the WIC program's impact on food expenditures is through the examination of factors influencing changes in food consumption behavior after the program is in operation. In this model, the difference between food expenditures reported at Time 1 and Time 2 is regressed on parallel differences or change scores for other factors measured at both times, along with the WIC factor.

Results of this change score analysis on the recall data reaffirm the findings derived from both the two-stage recall model and the diary analyses. In terms of food expenditures, the WIC program coefficient and coefficients for the interaction terms are not significantly different from zero (see Table VII-5). In other words, the differences in food expenditures between Time 1 and Time 2 among all the households in the sample cannot be attributed to the WIC program. This conclusion also applies to differences in grocery expenditures and in meals away from home.

Another way of examining the impact of WIC and the substitution and sharing components is through a simpler one-stage model in which food expenditures at Time 1, the time prior to enrollment into the WIC program, is included in the equation for food expenditures at Time 2. The conceptual framework for this specification is that the Time 1 food expenditures are viewed as a lagged variable instead of a pretreatment variable and therefore need adjustment. Results from this model are consistent with those of the two-stage model but do not offer the theoretical assurance of the two-stage framework. As Table VII-6 shows, WIC program participation seems to make no difference in the amount of food or grocery expenditures attributable to the pregnant women in the sample. As for the two-stage model, the interaction coefficient WIC*adults is negative and highly significant for food expenditures, becoming insignificant in the grocery expenditures equation. As mentioned earlier, this discrepancy is explained by the presence of meals away from home in the food expenditures equation. Again, the net result of this model's formulation seems to indicate that with the WIC coefficient and the sharing coefficients being statistically zero the value of substitution equals the value of the WIC package.

Table VII-5

Impact of WIC Participation on Monthly Food Expenditures
Differences Between Time 1 and Time 2 Interviews

Independent variables (D = difference)	Dependent variables ($/month)		
	Differences in food expenditures	Differences in grocery expenditures	Differences in meals away from home
Intercept	12.87	9.96	-0.21
D Adults	41.40***	31.28***	2.42***
D Children (0-5 years)	19.09*	13.96***	-0.96
D Guests	15.34***	14.31***	-0.46
D Food Stamps	0.12***	0.14***	-0.02***
D Lunch program	- 0.20	0.30	0.09
D Other WIC women	3.23	2.81	-0.87
D Children on WIC	- 0.68	3.35	-0.39
D Male head present	6.61	2.35	1.72
Whites	- 2.67	- 3.48	-1.34
Blacks	0.88	0.12	-2.42
Hispanics	- 6.37	- 4.88	0.33
Elementary school	-11.34	-10.52	0.07
Junior high school	13.28	10.80	3.23
High school	3.84	1.52	1.23
Post-high school	1.36	0.93	0.72
WIC	- 0.85	2.13	1.73
WIC*children	1.93	1.66	-0.02
WIC*adults	- 0.94	0.24	-0.10
N	4,985	4,985	4,985
R^2	0.13	0.17	0.01

*p < 0.05.
**p < 0.01.
***p < 0.001.

Source: Food Expenditures Recall Sample.

4. Effect of First-Stage Statistics

Although the first stage in the model explains food expenditures prior to program participation, some of its coefficients are nevertheless useful for analysis. The most important finding from the first-stage statistics is that WIC women at Time 1 reported significantly lower food expenditures than non-WIC women did, even when other variables that influence food expenditures, including total income, are controlled. As Table VII-7 shows, the coefficient for WIC women at the first interview suggests that families with WIC-eligible women spent approximately $13 less on food attributed directly to the woman than did non-WIC households. As discussed

Table VII-6

Impact of WIC Participation on Monthly Food Expenditures
One-Stage Model

Independent variables	Dependent variables ($/month)		
	Total food expenditures	Grocery expenditures	Meals away from home
Intercept	119.41***	94.06***	13.98
Food expenditures (Time 1)	0.29***		
Grocery expenditures (Time 1)		0.31***	
Meals away from home (Time 1)			0.16
Total income (Time 1)	(5.32) (10^{-3})	(5.15) (10^{-4})	(4.6) (10^{-3})
Children	22.39***	19.18***	-2.07
Adults	37.08***	23.76***	2.98
WIC	-4.24	-1.38	-4.04
WIC*children	-3.51	-4.29	1.52
WIC*adults	-10.14***	-2.46	-1.74
Presence of male head	3.71	2.45	2.18
Whites	-0.67	-4.05	0.63
Blacks	-14.46	-16.82*	-0.55
Hispanics	-21.60	-11.47	-1.72
Elementary school	-6.10	5.28	-7.37
Junior high school	-0.45	3.50	-2.22
High school	-11.06*	-6.60	-2.94
Post-high school	-7.07	-2.95	-1.31
Lunch program	0.11	0.01	0.05
Guests	20.19***	20.02***	-1.48
Food Stamps	0.11***	0.12***	-0.03
Other WIC women	7.04	0.06	1.47
Infants on WIC (1-3 months)	-24.19	-10.59	-0.43
Infants on WIC (4-12 months)	-10.07	-6.52	0.37
Children on WIC	3.18	5.42*	-0.53
N	4,981	4,981	4,981
R^2	0.37	0.42	0.11

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Source: Food Expenditures Recall Sample.

Table VII-7

Determinants of Monthly Food Expenditures for Sample Population Prior to Participation in WIC Program ($/Month)

Independent variable	Parameter estimate
Intercept	100.63***
Total monthly income	0.06***
Children (0-5 years)	17.99***
Children (5-10 years)	35.17***
Male teenagers	37.93***
Adult males	42.97***
Female teenagers	33.92***
Adult females	24.81***
Male head present	-6.48
Whites	0.37
Blacks	-15.39
Hispanics	-18.17
Elementary school	17.42
Junior high school	-1.45
High school	-9.43
Post-high school	-7.11
Lunch program	-0.86**
Guests	16.57***
Food Stamps	0.17***
Other WIC women	9.47
Infants on WIC (1-3 months)	-19.94
Infants on WIC (4-12 months)	-9.17
Children on WIC (1-5 years)	14.20***
WIC women	-13.56***
N	4,981
R^2	0.35

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Source: Food Expenditures Recall Sample.

previously, this difference is not statistically significant at Time 2 when these initial differences and other factors are controlled, as shown in the WIC coefficient in Table VII-3.

Table VII-7, as well as every first stage in the model shown in Volume IV, Appendix VII-C, shows the importance of the family's age-sex composition for determining food and grocery expenditures. Adult males seem to account for the largest individual contribution to monthly food expenditures, with the value of over $42 for each adult male in the household. They are followed closely by values for teenagers and children above 5 years of age. On the other hand, for each additional child less than 5 years of age, family food expenditures increase only by $18 per month. Guests are also an important food expenditures component, with a coefficient roughly equivalent to that of a child under 5 years of age. The increase in expenditures due to guests continues in the grocery expenditures equation (see Volume IV, Appendix VII-B, Table VII-B-2), but it becomes negative in the model for meals away from home (see Appendix VII-B, Table VII-B-3). This sign reversal clearly indicates that the presence of guests increases grocery expenditures but does not increase the cost of going out to eat.

Ethnic composition or education levels seem to have no significant effect on the way families spend money on food. However, definite significance, albeit small, is attached to other nutritional assistance programs. For example, participation in the Food Stamp Program increases food expenditures by 17 cents for every dollar received in terms of coupons. This effect declines to 10 cents at Time 2. Participation in the lunch program, on the other hand, has an expected negative effect on food expenditures since the program is delivered directly to its beneficiaries.

E. DISCUSSION

The results from the regression models converge to a consistent set of conclusions despite the varying degrees of strength of the data sources. That is, the evidence shows that program impact is mostly in terms of food composition rather than in terms of food expenditures. WIC program participants buy more WIC-type foods (presumably more nutritious) than nonparticipants do, even though no significant differences in total food expenditures were found between the WIC and non-WIC groups (see Figure VII-1).

1. Impact on WIC Women

The food expenditures recall data, although a cost-effective source, provide only weak evidence of program impact. The statistically nonsignificant coefficients for WIC women in the food expenditures equations show values that are very close to the limits addressed by the power of the survey design: around $5 a month. In other words, results from the recall data indicate that if the WIC program affects food expenditures, it was not statistically detectable in this study. This assertion is supported by the low-income elasticity for food expenditures shown by the sample population, the power of the survey design, and the relatively low exchangeability of WIC program benefits.

The income elasticity of food expenditures found among the WIC and non-WIC families are low but consistent with the elasticities found among

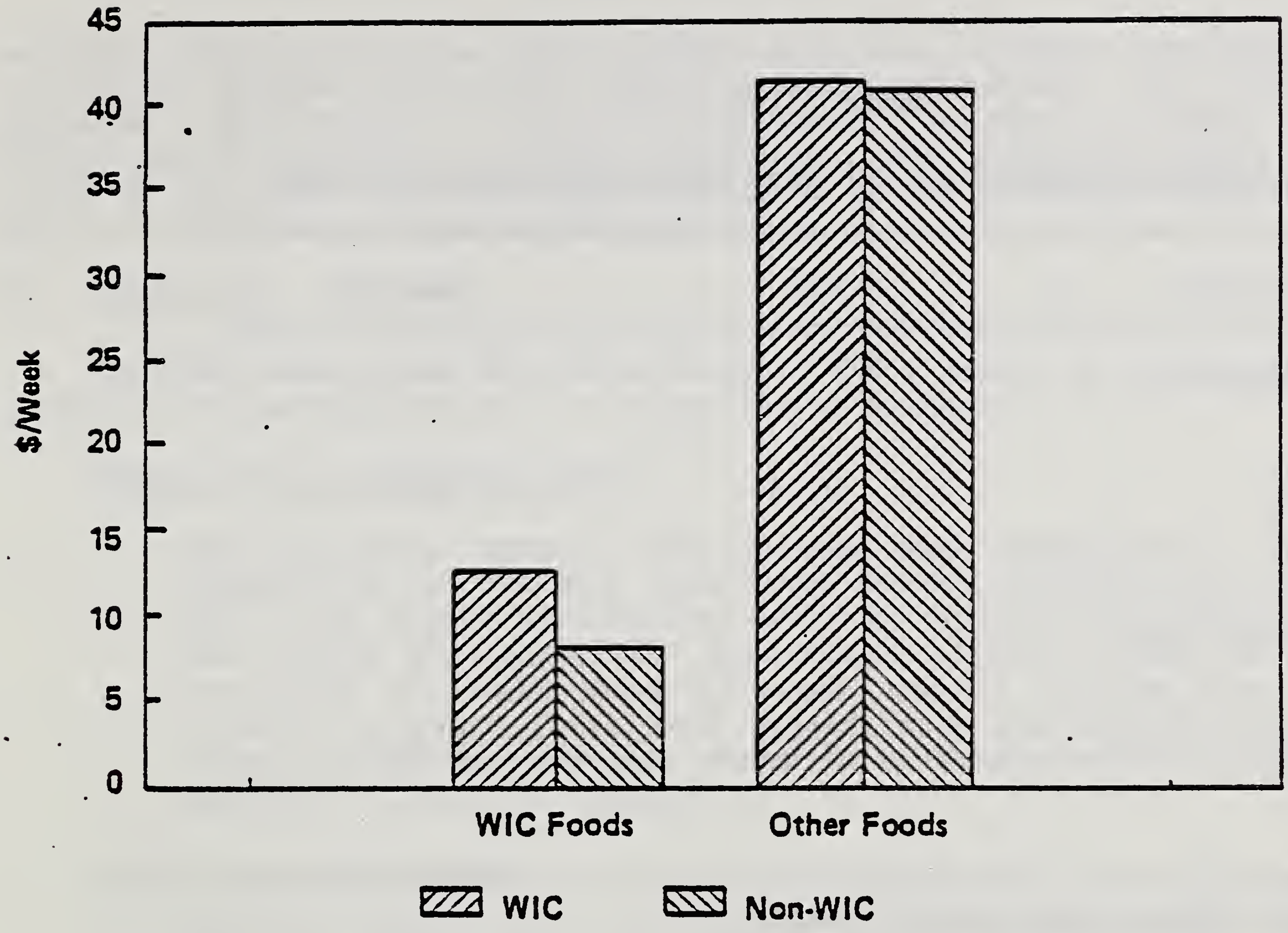


Figure VII-1. Weekly food expenditures (by food group).

similar socioeconomic groups in similar studies. Table VII-8 shows the elasticities of income with respect to food and grocery expenditures. These elasticities are derived from the regression results shown in Volume IV, Appendix VII. For a WIC family, for instance, the table indicates that an income increase of 1 percent will increase their grocery expenditures 0.116 percent. Hence, if a monthly WIC package with an average value of $30 were given to a WIC family, their grocery bill would increase an average of $3.60 a month. Therefore, even if the WIC program positively impacted their food expenditures, the value of that impact would be lower than the lowest detectable value in the recall design, and therefore the WIC coefficient would likely be nonsignificant.

Unchanged levels of food expenditures, however, do not imply unchanged use of WIC-type foods. Here, the restrictive nature of the WIC program in fact creates a priori restrictions on the nutrient composition of the market basket for the WIC family. That is, the income increase generated by WIC is tied to food instruments redeemable for specific foods and to the presence of an eligible pregnant woman in the household. Thus, a WIC family receives instruments with a lower degree of exchangeability for cash than other nutritional assistance programs e.g., Food Stamps. As a conse-

Table VII-8

Mean Income Elasticities for Food and Grocery Expenditures

Income elasticity	WIC	Non-WIC
Food expenditures		
$\left(\frac{\partial FE}{\partial Y}\right)\left(\frac{\bar{Y}}{\overline{FE}}\right)$	0.18	0.21
Grocery expenditures		
$\left(\frac{\partial GE}{\partial Y}\right)\left(\frac{\bar{Y}}{\overline{GE}}\right)$	0.116	0.138

Source: Food Expenditures Recall Sample.

quence, even if the family spent cash income equal to the value of the WIC transfer, the instruments could be used only to purchase WIC foods, which generally have a higher nutrient density. Due to these restrictions, a change in the food purchasing pattern of WIC families is expected, the magnitude of which may be compared to the purchases of non-WIC families. Results from the diary data confirm these expectations. Expenditures on WIC-type foods among WIC families are significantly greater than among non-WIC families. Although there is no direct evidence that such expenditures are derived from program participation, indirect evidence is provided by the fact that expenditures in other food groups are the same for WIC and non-WIC families. Hence, the evidence suggests a positive program impact in increased use of nutritious WIC-type foods. Furthermore, this increment in WIC-type foods used is unequivocally attributable to the WIC woman.

2. Impact on WIC Families

The impact of the WIC program on unintended recipients seems to be negligible. Again, as in the case of the recall analysis, if there is an impact it is not detectable by this survey. However, unlike the case of WIC women, the program for WIC children has significant and positive effects on both food expenditures and purchasing patterns. The statistical

evidence gathered from the recall models shows that children participating in the WIC program account for higher grocery expenditures than non-WIC children. The difference between WIC and non-WIC children is almost $8 a month (see Table VII-3). In the diary data, WIC children account for nearly $6.00 a week more than non-WIC children in the purchase of groceries and for $2.25 more per week in WIC-type foods.

F. CONCLUSIONS

The main conclusions from this study of WIC's impact on food expenditures and purchasing patterns are summarized as follows:

Expenditures on WIC-type foods

Based on diary records, WIC families show significantly higher expenditures on WIC-type foods than non-WIC families do. Moreover, this higher expenditures level is directly attributable to WIC program participation. Significant effects on use of WIC-type foods are found among WIC women, and WIC children less than 5 years of age. Total food expenditures and expenditures on other food groups were not found to be statistically different among WIC and non-WIC families.

Substitution and sharing

Based on recall data, WIC families did not increase their total food expenditures as a result of program participation. The recall data analysis indicates that the value of the WIC package is almost totally substituted and that no sharing has occurred. An important caveat to this conclusion is that the survey power was insufficient to detect as significant levels of expenditures lower than one-sixth of the value of the average WIC package.

Meals away from home

Families in the WIC program spend less on meals eaten out than do non-WIC families, even after the increase in real income brought about by WIC. Because participation in the WIC program is strongly associated with lower expenditures in meals away from home, the family budget's efficiency apparently increases.

Age-sex composition of family

The family age-sex composition is the primary factor explaining family food expenditures with gender and age accounting for most of the differences found among family members. As expected, children have smaller effects on food expenditures than do adults, and females have smaller effects than do males.

Quality of Diet

Increased expenditures on WIC-type foods and evidence of lower expenditures on meals away from home suggest potentially more nutritious diets and improved nutrient quality of the diets of participants. The findings of the Food Expenditures Study, therefore, appear consistent with the affect of WIC benefits on dietary intake.

REFERENCES

Adelson, Saydye F. 1960. "Some Problems in Collecting Dietary Data from Individuals." Journal of the American Dietetic Association, 36, pp. 453-461.

Akin, J., D. Guilkey, and B. Popkin. 1983. "The School Lunch Program and Nutrient Intake: A Switching Regression Analysis." American Journal of Agricultural Economics, 65, pp. 477-485.

Adrian, J. and R. Daniel. 1976. "Impact of Socioeconomic Factors on Consumption of Selected Food Nutrients in the United States." American Journal of Agricultural Economics, 58, pp. 31-38.

Anderson, G. H, R. D. Peterson, and G. H. Beaton. 1982. "Estimating nutrient deficiencies in a population from dietary records: The use of probability analyses." Nutrition Research 2:409-415.

Argeanas, S., and I. Harrill. 1979. "Nutrient intake of lactating women participating in the Colorado WIC Program." Nutrition Reports International 20(6):805-810.

Bailey, L. B., B. O'Farrell-Ray, C. S. Mahan, and D. Dimperio. 1983. "Vitamin B6, iron, and folacin status of pregnant women." Nutrition Research 3:783-793.

Balogh, Miriam, Harold A. Kahn, and Jack H. Medalie. 1971. "Random Repeat 24-Hour Dietary Recalls." The American Journal of Clinical Nutrition, 24, pp. 304-310.

Basiotis, Peter, Mark Brown, S. R. Johnson, and Karen J. Morgan. 1983. "Nutrient Availability, Food Costs, and Food Stamps." American Journal of Agricultural Economics, 65(4), pp. 685-693.

Basiotis, P. 1983. "Food Costs, Nutrient Availability, and Nutrient Intake of Food Stamp Program Eligible Households: Analysis in a Household Production Framework." Ph.D. Dissertation. University of Missouri. Columbia.

Baxter, J., L. Fleshood, and J. Scheer. 1983. "Reduced frequency of low birthweights among women receiving WIC in Tennessee." Abstract submitted for the 1983 meeting of the American Public Health Association. (Separate data on regions within the State also included in a report to FNS).

Beaton, G. H., and H. Ghassemi. 1982. "Supplementary feeding programs for young children in developing countries." Amer. J. Clinical Nutrition 35:864-916.

Beaton, G. H., J. Milner, P. Corey, V. McGuire, M. Cousins, E. Stewart, M. deRamos, D. Hewitt, P. V. Grambsch, H. Kassim, and J. A. Little. 1979. "Sources of variance in 24-hour dietary recall data: Implications for nutrition study design and interpretation." Amer. J. Clinical Nutrition 32:2546-2559.

Belshaw, J. 1982. "WIC among the Navajos." Community Nutritionist 1:3, 10-12.

Bendick, M., T. H. Campbell, D. L. Bowden, and M. Jones, The Urban Institute. 1976. "Efficiency and effectiveness in the WIC program delivery system." Miscellaneous Publication No. 1338, 1-216. U.S. Department of Agriculture.

Blaylock, J. and D. Smallwood. 1981. "Impact of Household Size and Income on Food Spending Patterns." Washington D.C.: Economic and Statistical Service. U.S. Dept. of Agrculture, MED Tech. Bull., 1650.

Brazelton, T. B., E. Tronick, A. Lechtig, R. E. Lasky, and R. E. Klein. 1977. "The behavior of nutritionally deprived Guatemalan infants." Dev. Med. Child Neurol. 19:364-372.

Brevard County Health Department WIC Staff. 1977. "Report of WIC data." Unpublished report. Rockledge, Florida.

Buncher, C. R. 1969. "Cigarette smoking and duration of pregnancy." Amer. J. Obstet. Gynecol. 103(7):942-946.

Burk, Marguerite C. and Eleanor M. Pao. 1976. "Methodology for Large-Scale Surveys of Household and Individual Diets." Home Economics Research Report No. 40, ERS/USDA.

California Department of Health Services, Community Health Services Division. 1982. "Retrospective study of the Special Supplemental Food Program for Women, Infants, and Children (WIC)." Unpublished report. Maternal and Child Health Branch, Sacramento, California.

Carabello, D., C. Doyle, S. Kananovich, L. Meisler, and P. Wlodarczyk. 1978. "An evaluation of a Supplementary Feeding Program for Women, Infants, and Children." Final report, student project. Yale University School of Medicine.

CDC. 1978. Centers for Disease Control, Nutrition Section. "CDC analysis of nutritional indices for selected WIC participants." U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Atlanta, Georgia.

Chen, J. S. 1983. "Simultaneous Equations Models with Qualitatve Dependent Variables: A Food Stamp Program Participation and Food Cost Analysis." Ph.D. Dissertation, University of Missouri, Columbia.

Christie, D. D., and L. B. Gale. 1979. "WIC program involvement in the prevention of mental retardation." (Mimeograph) New Jersey State Department of Health, John Fitch Plaza, Trenton, New Jersey.

Cohen, J., and P. Cohen. 1983. Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Collins, T., J. Leeper, R. S. Northrup, and S. Demeillier. 1981. "Integration of WIC program with other infant mortality programs. Final report." Appalachian Region Commission Report, University of Alabama, Tuscaloosa, Alabama.

Comptroller General of the United States. 1979. "The Suppplemental Food Program for Women, Infants, and Children (WIC)--How can it work better?" Washington, D.C.: U.S. General Accounting Office.

Cook, R. A., S. B. Davis, F. H. Radke, and M. E. Thornbury. 1976. "Nutritional status of Head Start and nursery school children. I. Food intake and anthropometric measurements." J. Amer. Dietetic Assoc. 68:120-126.

Cravioto, J., and E. R. DeLicardie. 1975. "Mother-infant relationship prior to the development of clinically severe malnutrition in the child." In: Western Hemisphere Nutrition Congress IV, edited by P. L. White and N. Selvey, pp. 126-137. Acton, Massachusetts: Publishing Sciences Group.

Cronk, C. E., and A. F. Roche. 1982. "Race and sex-specific reference data for triceps and subscapular skinfolds and weight/stature." Amer. J. Clinical Nutrition 35:347-354.

Davidson, M. L. "The multivariate approach to repeated measures." BMDP Technical Report No. 75. BMDP Statistical Software.

Deterding, J., A. Wickiser, and J. Smith. 1983. "The benefits of the WIC program in three Indian communities." University of Nebraska Medical Center, Omaha, Nebraska.

Development Associates, Inc. 1979. " Evaluation of the WIC migrant demonstration project: A final report." Unpublished report. Submitted to Food and Nutrition Service, U.S. Department of Agriculture. Arlington, Virginia.

Drayton, P. K. D. 1982. "An evaluation of the women, infants, and children nutrition education intervention program for high-risk pregnant women in three centers of Illinois." Doctoral Thesis. Southern Illinois University at Carbondale, Illinois.

Dunn, L. M., and L. M. Dunn. 1981. "Peabody Picture Vocabulary Test - revised (form M-regular edition)." Circle Pines, Minnesota: American Guidance Service.

Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1976a. Medical evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC) (6 volumes). Department of Nutrition, University of North Carolina, School of Public Health, Chapel Hill, North Carolina.

Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1976b. "Medical evaluation of the Special Supplemental Food Program for Women, Infants and Children." Select Committee on Nutrition and Human Needs, U.S. Senate. Washington, D.C.: U.S. Government Printing Office.

Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1979. "Medical evaluation of the Special Supplemental Food Program for Women, Infants, and Children." Amer. J. Clinical Nutrition 32:677-692.

Endres, et al. 1976a, b.

Endres, J. M., M. Sawicki, J. A. Casper. 1981. "Dietary assessment of pregnant women in a supplemental food program." J. Amer. Dietetic Assoc. 79:121-126.

Federal Register. 1980. Part 5. Department of Agricultural Food and Nutrition Service, Special Supplement, WIC. November 12, 1980, pp. 74854-74877.

Fleshood, L., M. H. Buckner, A. F. Hatchett, J. A. Hayes, J. Seals, C. M. Smith, P. A. Scanlon, and J. N. Wallace. 1983. "Is WIC reducing the prevalence of low birthweight and infant mortality?" Paper presented during the 106th American Public Health Association meeting, 1978.

George, N. N. 1982. "Prepregnancy weights, weight gains, and other factors related to birthweights of infants born to overweight women." Dissertation, in partial fulfillment of the requirement for the Degree of Master of Education. Submitted to the Graduate College of Bowling Green State University.

Georgia Office of Nutrition, Department of Human Resources. 1982. "WIC nutrition survey." Unpublished report.

Goldberg, H. E. 1982. "An evaluation of the effectiveness of the WIC program in terms of height, birthweight, weight, and hematocrit." Unpublished report. The Mount Sinai Medical Center, New York.

GAO, U.S. General Accounting Office. 1984. "WIC evaluations provide some favorable but no conclusive evidence on the effects expected for the Special Supplemental Program for Women, Infants, and Children." Report to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, Washington, D.C. January 30, 1984.

Gortmaker, S. 1979. "Effects of prenatal care upon the health of the newborn," Amer. J. Public Health 69:653-7.

Grantham-McGregor, S., M. Stewart, C. Powell, and W. N. Schofield. 1979. "Effect of stimulation on mental development of malnourished child." Lancet. 2:200-201.

Grantham-McGregor, S., M. E. Stewart, and W. N. Schofield. 1980. "Effect of long-term psychological stimulation on mental development of severely malnourished children." Lancet 2:785-789.

Grantham-McGregor, S., W. N. Schofield, and L. Harris. 1983. "Effect of psychosocial stimulation on mental development of severely malnourished children: An interim report." Pediatrics 72:239-243.

Grossman, M., and Jacobowitz, S. 1981. "Variations in infant mortality rates among counties of the United States: The roles of public policies and programs." Demography 18:695-713.

Habicht, J. P., A. Lechtig, C. Yarbrough, and R. E. Klein. 1974. "Maternal nutrition, birthweight, and infant mortality." In: Size at Birth, edited by K. Elliott and J. Knight, pp. 353-377. Ciba Foundation Symposium 27 (New Series). Amsterdam: Elsevier.

Haddad, L. J., and C. E. Willis. 1983. "An analysis of factors leading to early enrollment in the Massachusetts Special Supplemental Feeding Program for Women, Infants, and Children." Research Bulletin No. 682. Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst.

Healthwise, Inc. 1980. "WIC nutrition education evaluation final report." Submitted to Idaho Department of Health and Welfare, WIC Program Office, Boise, Idaho.

Heimendinger, J. 1981. "I. The effect of WIC on the growth of infants and children. II. The use of growth standards in assessing WIC impact on infants and children." Unpublished doctoral thesis. Harvard University, Boston, Massachusetts.

Heimendinger, J., and N. Laird. 1983. "Growth changes measuring the effect of an intervention." Evaluation Rev. 7, 80-95.

Hemminki, E., and B. Starfield. 1978. "Routine administration of iron and vitamins during pregnancy: Review of controlled clinical trials." Brit. J. Obstet. Gynaecol. 85:404-410.

Hicks, L. E., R. A. Langham, and J. Takenaka. 1982. "Cognitive and health measures following early nutritional supplementation: A sibling study." Amer. J. Public Health 72(10):1110-1118.

Hicks, L. E., R. A. Langham, and J. Takenaka. 1983. "Interpretation of behavioral findings in studies of nutritional supplementation." Amer. J. Public Health 73(6):695-697.

Himes, J. H. 1984. Personal communication.

Himes, J. H., A. F. Roche, and D. Thissen. 1981. Parent-specific Adjustments for Assessment of Recumbent Length and Stature. New York: S. Karger.

Hytton, F. E., and I. Leitch. 1971. The Physiology of Human Pregnancy. London: Blackwell Scientific Publications.

Johnston, F. E., P. V. Hamill, and S. Lemeshow. 1974. "Skinfold thickness in a national probability sample of U.S. males and females age 6 through 17 years." Amer. J. Physical Anthropol. 40: 321-324.

Kaminski, M., C. Rumeau-Rouquette, and D. Schwartz. 1976. "Consommation d'alcohol chez les femmes enceintes et issue de la grossesse." Rev. Epidem. et Sante Publ. 24:27-40.

Kennedy, E. T., S. Gershoff, R. Reed, and J. E. Austin. 1982. "Evaluation of the effect of WIC supplemental feeding on birth weight." J. Amer. Dietetic Assoc. 80(3):220-227.

Kennedy, E. T., and S. Gershoff. 1982. "Effect of WIC supplemental feeding on hemoglobin and hematocrit of prenatal patients." J. Amer. Dietetic Assoc. 80(3):227-230.

Kenny, D. 1984. Personal communication.

Kessel, S., and J. Villar. 1983. "Secular trends of the incidence of low birthweight in the United States, 1970-1980: A bivariate analysis." Abstract of a paper presented at the Sixteenth Annual Meeting of the Society for Epidemiologic Research, Winnipeg, Manitoba, June 15-17, 1983.

Kessner, D. M., J. Singer, C. E. Kalk, et al. 1973. "Infant death: An analysis by maternal risk and health care." Washington, D.C.: Institute of Medicine, National Academy of Sciences.

Kotelchuck, M., M. Anderka, L. J. Stern, M. Hudson, and L. Graham-Mero. 1982. "Massachusetts Special Supplemental Food Program for Women, Infants, and Children (WIC) followup study: Final report." Massachusetts Department of Public Health, Boston, Massachusetts.

Kotelchuck, M., J. B. Schwartz, M. T. Anderka, and K. S. Finison. 1981. "Massachusetts Special Supplemental Food Program for Women, Infants, and Children (WIC) evaluation project: Final report." Massachusetts Department of Public Health, Boston, Massachusetts.

Kotelchuck, M., J. B. Schwartz, M. T. Anderka, and K. S. Finison. 1984. "WIC participation and pregnancy outcomes: Massachusetts Statewide Evaluation Project." (To be published in the Amer. J. Public Health, October 1984.) Massachusetts Department of Public Health, Boston.

Kristal, A. R., and D. Rush. 1984. "Maternal nutrition and duration of gestation: A review." In Clinical Obstetrics and Gynecology, edited by I. R. Merkatz. Philadelphia: J. B. Lippincott, in press.

Langham, R. A., B. W. Dupree, E. H. Atkins, and P. E. Schilling. 1975. "Impact of the WIC program in Louisiana." Unpublished report. Louisiana State Health Department, New Orleans.

Lozoff, B. 1984. Personal communication.

Madden, J. P., S. J. Goodman, and H. A. Guthrie. 1976. "Validity of the 24-Hour Recall." Journal of the American Dietetic Association, 68, 1976, pp. 143-147.

Martinez, G. A., and J. P. Nalenzienski. 1979. "The recent trend in breast-feeding." Pediatrics 64(5):686-692.

Martinez, G. A., and J. P. Nalenzienski. 1981. "1980 update: The recent trend in breast-feeding." Pediatrics 67(2):260-263.

Martinez, G. A., and D. A. Stahle. 1982. "The recent trend in milk feeding among WIC infants." Amer. J. Public Health 72(1):68-71.

Martorell, R., R. E. Klein, and H. Delgado. 1980. "Improved nutrition and its effects on anthropometric indicators of nutritional status." Nutrition Reports Intl. 21: 219-230.

Massachusetts Executive Office of Human Services, Department of Public Health. 1983, "1983 Massachusetts nutrition survey executive summary." Division of Family Health Services, Boston.

McCarthy, D. 1972. Manual for the McCarthy Scales of children's abilities. New York, New York: The Psychological Corporation.

McKay, H., A. McKay, and L. Sinisterra. 1974. "Intellectual development of malnourished preschool children in programs of stimulation and nutritional supplementation." In: Early Malnutrition and Mental Development: Symposia of the Swedish Nutrition Foundation XII, edited by J. Cravioto, L. Hambraeus, and B. Vahlquist, pp. 226-233. Uppsala, Sweden: Almquist and Wiksell.

Metcoff, J., P. Costiloe, W. Crosby, H. Sandstead, C. E. Bodwell, and E. Kennedy. 1982. "Nutrition in pregnancy ("NIP") final report (USDA)." (Report to the Food and Nutrition Service, USDA.) University of Oklahoma Health Sciences Center, Oklahoma City.

Montana Department of Health and Environmental Sciences. 1982. "Executive Summary, WIC teenage pregnancy outcome project." Report submitted to the U.S. Department of Agriculture.

Mora, J. O., B. de Paredes, M. Wagner, I. de Navarro, J. Suescun, N. Christiansen, and M. G. Herrera. 1979. "Nutritional supplementation and the outcome of pregnancy. 1. Birthweight." Amer. J. Clinical Nutrition 35:864-916. [32:455-462]

NRC: National Research Council, Food and Nutrition Board. 1980. Recommended Dietary Allowances. Washington, D.C.: National Academy of Sciences.

Niswander, K. R., and M. Gordon. 1972. "The women and their pregnancies. The collaborative perinatal study of the NINCDS." DHEW Publication No. (NIH) 73-379. Washington, D.C.: U.S. Government Printing Office.

Nutt, P. C., M. Wheeler, and R. A. Wheeler. 1981. "Social program evaluation revisited: The WIC program." The Ohio State University, American Institute of Decision Sciences.

Osofsky, H. J. 1975. "Relationships between prenatal medical and nutritional measures, pregnancy outcome, and early infant development in an urban poverty setting. I. The role of nutritional intake." Amer. J. Obstet. Gynecol. 123:682-690.

Paige, D. 1983. "Evaluation of the WIC Program in infants on the Eastern Shore of Maryland." Johns Hopkins University, Department of Maternal and Child Health, Baltimore.

Pelto, J. M. 1982. "Results of a nutrition intervention program: The WIC program in Alaska." Alaska Medicine 24:14-17.

Pirani, B. B. K., and I. MacGillivray. 1978. "Smoking during pregnancy. Its effect on maternal metabolism and fetoplacental function." Amer. J. Obstet. Gynecol. 52:257-263.

Pollitt, E., and R. Lorimor. 1983. "Effects of WIC on cognitive development." Amer. J. Public Health 73(6):698-700.

Pollitt, E., and C. Thomson. 1977. "Protein-calorie malnutrition and behavior: A view from psychology." In: Nutrition and the Brain, Vol. 2, edited by R. J. Wurtman and J. J. Wurtman, pp. 261-306. New York: Raven Press.

Quackenbush, G. and J. D. Shaffer. 1960. "Collecting Food Purchase Data by Consumer Panel--A Methodological Report on the MSU Consumer Panel." 1951-58. Michigan State University Agric. Expt. Sta. Bull., 279.

RTI: Research Triangle Institute. 1981. "Evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC). Evidence from the literature." Research Triangle Park, North Carolina.

RTI: Research Triangle Institute. 1984a. "National evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC). Final report on quality control for premachine editing, dietary coding, data entry, and machine editing." Unpublished. Submitted to the Food and Nutrition Service, USDA.

RTI/NYSRF: Research Triangle Institute/New York State Research Foundation. 1983. "The National WIC Evaluation: A study of health and nutrition of mothers and their children. Field Procedures Manual." Unpublished.

Roche, A. 1980. "Possible catch up growth of the brain in man." Acta Medica Auxologica 12:165-179.

Roche, A. F., and J. H. Himes. 1980. "Incremental growth charts." Amer. J. Clinical Nutrition 33:2141-2152.

Rosso, P., and R. Kava. 1980. "Effects of food restriction on cardiac output and blood flow to the uterus and placenta in the pregnant rat." J. Nutrition 110(12):2350-2354.

Rush, D. 1974. "Examination of the relationship between birthweight, cigarette smoking during pregnancy, and maternal weight gain." J. Obstet./Gynecol. Brit. Commonwealth 81:746-752.

Rush, D. 1980b. "Cigarette smoking, nutrition, social status, and perinatal loss: Their interactive relationships." In: Human Embryonic and Fetal Death, edited by I. H. Porter and E. B. Hook, pp. 207-219. New York: Academic Press.

Rush, D. 1982. "Is WIC Worthwhile?" Amer. J. Public Health 72(10):1101-1103.

Rush, D. 1983. "In response to Hicks, et al." Amer. J. Public Health 73(6):700-701.

Rush, D. 1984. "The behavioral consequences of protein-energy deprivation and supplementation in early life: An epidemiologic perspective." In: Nutrition and Behavior, Volume 5, of Human Nutrition: A Comprehensive Treatise, edited by J. R. Galler. New York: Plenum Publishing Corp.

Rush, D., et al. 1982. Unpublished data.

Rush, D., J. M. Alvir, L. Artiola, W. Condelli, G. Garbowski, J. Leighton, N. Sloan, D. G. Horvitz, D. Duncan, R. Folsom, S. Johnson, R. Kulka, J. Lessler, and R. P. Moore. 1982. "Proposed designs: Studies of pregnant women and children. National Evaluation of the Special Supplemental Food Program for Women, Infants, and Children (WIC): Final Report." Unpublished. Submitted to the Food and Nutrition Service, USDA.

Rush, D., and A. Kristal. 1982. "Methodologic studies during pregnancy: The reliability of the twenty-four hour dietary recall." Amer. J. Clinical Nutrition 35:1259-1268.

Rush, D., H. Davis, and M. W. Susser. 1972. "Antecedents of low birthweight in Harlem, New York City." Intl. J. Epidemiology 1:393-405.

Rush, D., Z. Stein, and M. Susser. 1980a. "A randomized controlled trial of prenatal nutritional supplementation in New York City." Pediatrics 65:683-697.

Rush, D., Z. Stein, and M. Susser. 1980b. Diet in Pregnancy: A Randomized Controlled Trial of Nutritional Supplements. Birth defects. Original Article Series 16, No. 3. New York: Alan R. Liss (March of Dimes Birth Defects Foundation).

Rye, J., M. White, and M. Majchrzak. 1978a. "Intervention outcomes in Arizona's WIC program, July 1976 through March 1977." Unpublished report. Pima County, Tucson, Arizona.

Rye, J., M. White, and M. Majchrzak. 1978b. "Does objective-based health education affect positive changes in the health status of WIC program clients?" Unpublished report. A report of preliminary findings in Pima County, Arizona. Tucson, Arizona.

Schaeffer, E., and M. Edgerton. 1976. "Infant Behavior Inventory." Unpublished.

Schelzel, G., and M. A. Britton. 1978. "An assessment of the WIC program in Pennsylvania." Unpublished report. Pennsylvania Health Department.

Schramm, W. F. 1983. "WIC prenatal participation and its relationship to newborn Medicaid costs in Missouri: A cost/benefit analysis." Missouri Center for Health Statistics, Jefferson City, Missouri.

Sharbaugh, C., C. Morris, and C. Mahan. 1977. "The North Central Florida WIC evaluation." Unpublished report. North Central Florida Maternity and Infant Care Project, Gainesville, Florida.

Silverman, P. R., L. H. Kuller, and D. C. Kolodner. 1982. "The effect of a local prenatal nutrition supplementation program (WIC) on birth weight." Unpublished manuscript. Allegheny County Health Department, Pittsburgh, Pennsylvania.

Slonim, A. B., K. M. Kolasa, and M. A. Baso. 1981. "The cultural appropriateness of the WIC program in Cherokee, North Carolina." J. Amer. Dietetic Assoc. 79:164-168.

Smallwood, David and James Blaylock. 1983. "Analysis of Food Stamp Program Participation and Food Expenditures." Mimeograph, Economic Research Service, United States Dept. of Agriculture, January.

Stebbins, L. 1981. Unpublished APHA abstract.

Stockbauer, J., and C. R. Blount. 1983. "Evaluation of the prenatal participation component of the Missouri WIC program." Missouri Department of Social Services, Division of Health, Jefferson City, Missouri.

SDC: Systems Development Corporation, Sally Hanes. 1982. Personal communication.

Taggart, N. R., R. M. Holliday, W. Z. Billewicz, F. E. Hytten, and A. M. Thomson. 1967. "Changes in skinfolds during pregnancy." Brit. J. Nutrition 21:439-451.

Thenen, S. W. 1982. "Folacin content of supplemental foods for pregnancy." J. Amer. Dietetic Assoc. 80:237-241.

USDA: U.S. Department of Agriculture, Food and Nutrition Service. 1977. "Special Supplemental Food Program for Women, Infants, and Children." Reprinted from the Federal Register of August 26, 1977 (42 F.R. 43205). Washington, D.C.: U.S. Government Printing Office.

USDA: U.S. Department of Agriculture, Human Nutrition Information Service. 1975. "Foods commonly eaten by individuals: Amount per day and per eating occasion." Home Economics Research Report No. 44, Hyattsville, Maryland. December 1975.

USDA: U.S. Department of Agriculture, Human Nutrition Information Service. 1980. "USDA Nutrient Data Base for Individual Intake Surveys, Release 1." Hyattsville, Maryland: Consumer Nutrition Center, Survey Statistics Group.

USDA: U.S. Department of Agriculture, Human Nutrition Information Service. 1982. "Composition of foods, breakfast cereals, raw.processed.prepared." Agriculture handbook No. 8-8. Revised. July 1982.

USDA: U.S. Department of Agriculture, Human Nutrition Information Service. 1982. "USDA Nutrient Data Base for Standard Reference, Release 2." Hyattsville, Maryland: Consumer Nutrition Center, Survey Statistics Group.

USDA: U.S. Department of Agriculture, Human Nutrition Information Service. 1982. "Nationwide Food Consumption Survey, 1977-78. Preliminary Report No. 13, Food and nutrient intakes of individuals in 1-day low-income households, November 1979-March 1980." Hyattsville, Maryland: HNIS, USDA.

USDA: U.S. Department of Agriculture, Science and Education Administration. 1980. "Nationwide Food Consumption Survey 1977-78, Preliminary Report No. 2, Food and nutrient intakes of individuals in 1 day in the United States, Spring 1977." Washington, D.C.: Office of the Director, Science and Education Administration.

USDA: U.S. Department of Agriculture, Science and Education Administration. 1978. "Nationwide Food Consumption Survey, Basic Survey, 1977-78." Unpublished data.

USDA: U.S. Department of Agriculture, Science and Education Administration. "Nationwide Food Consumption Survey, 1977 Low Income Survey." Unpublished data.

USDA: U.S. Department of Agriculture, Science and Education Administration. "Nationwide Food Consumption Survey, 1980 Low Income Survey." Unpublished data.

USDHEW: U.S. Department of Health, Education, and Welfare. 1972. "The Ten-State Nutrition Survey, 1968-1970. III. Clinical, Anthropometry, Dental." DHEW Publication No. (HSM) 72-8131, Atlanta, Georgia.

USDHEW: U.S. Department of Health, Education, and Welfare. 1974. "Preliminary findings of the first Health and Nutrition Examination Survey, United States, 1971-1972, Dietary intake and biochemical findings." DHEW Publication No. (HRA) 74-1219-1, Rockville, Maryland.

USDHEW: U.S. Department of Health, Education, and Welfare, National Center for Health Statistics. 1976a. "Health and Nutrition Examination Survey: HANES II. Examination Staff Procedures Manual for the Health and Nutrition Examination Survey, 1976-1979, Part 15A."

USDHEW: U.S. Department of Health, Education, and Welfare. 1976b. "NCHS Growth Charts, 1976." Vital and Health Statistics. DHEW Publication No. (HRA) 76-1120. Washington, D.C.: U.S. Government Printing Office.

USDHEW: U.S. Department of Health, Education, and Welfare. 1981. "A guide to pediatric weighing and measuring." Centers for Disease Control, Atlanta, Georgia, and Health Services Administration, Rockville, Maryland. DHEW Publication No. 740-010/4557. Washington, D.C.: U.S. Government Printing Office.

USDHHS: U.S. Department of Health and Human Services, National Center for Health Statistics. 1981. "Basic data on anthropometric measurements and angular measurements of the hip and knee joints for selected age groups 1-74 years of age, United States, 1971-75." DHHS Publication No. (PHS) 81-1669, Rockville, Maryland.

USDHHS: U.S. Department of Health and Human Services, Centers for Disease Control. 1978. "CDC analysis of nutritional indices for selected WIC participants." Centers for Disease Control, Nutrition Section, Atlanta, Georgia.

USDHHS: U.S. Department of Health and Human Services, Health Resources Administration. "Second Health and Nutrition Examination Survey, 1976-79." Unpublished data.

Viegas, O. A. C., P. H. Scott, T. J. Cole, H. N. Mansfield, D. Wharton, and B. A. Wharton. 1982. "Dietary protein supplementation of pregnant Asian mothers at Sorrento, Birmingham. I. Unselective during second and third trimester." Brit. Med. J. 285:589-592.

Vuori, L., N. Christiansen, J. Clement, J. O. Mora, M. Wagner, and M. G. Herrera. 1979. "Nutritional supplementation and the outcome of pregnancy. II. Visual habituation at 15 days." Amer. J. Clinical Nutrition 32:463-469.

WHO: World Health Organization. 1983. Measuring Change in Nutritional Status. Geneva, Switzerland: WHO.

Weiler, P. G., H. P. Stalker, S. W. Jennings, and W. T. Fister. 1979. "Anemia as a criterion for evaluation of a Special Supplemental Food Program for Women, Infants, and Children." Pediatrics 63:584-590.

Wigglesworth, J. S. 1981. "Fetal lung growth and lung hypoplasia in animals and man." In: Fetal Growth Retardation, edited by F. A. Van Assche and W. B. Robertson, pp. 242-251. New York: Churchill Livingston.

Williams, J. T. 1982. "Wyoming WIC evaluation." Unpublished letter report to Food and Nutrition Service.

Winer, B. J. 1971. Statistical Principles in Experimental Design. Second edition. New York: McGraw-Hill.